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# Aggressive Behavior





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# EDITORIAL

The council of the International Society for Research on Aggression asked me to take over the task of Editor-in-Chief of Aggressive Behavior at the Biennial ISRA Meeting in October 1978. I am happy to do so. The task is made easier by the work of my predecessor, Kenneth Moyer, who very ably led the journal from the idea stage to its present position as a forum for the best work of scientists in a variety of fields. A new multidisciplinary journal has an unusual problem since it must become visible to investigators and readers in several fields, each of which has its own journals whose standards are known. I believe that Aggressive Behavior has now become established as a respected journal for a variety of researchers.

Inevitably, each editor of a journal helps to characterize it. My aim is to foster mutual interest and even a rapprochement among those who study aggressive behavior from social and biological perspectives. To this end, Stuart Taylor and Suzanne Steinmetz have agreed to become Associate Editors, joining Paul Brain and Alan Leshner whose research has been mainly on the biological bases of aggression. Aggressive Behavior will continue to be a journal with a broad perspective, and I want to make sure that all researchers in aggression consider us as a real option when they want to publish something good. By having associate editors and an editorial board who represent many fields, I hope that even the most reluctant potential author can be persuaded thereby to entrust us with his or her opus magnum, confident that it will be reviewed by appropriate experts who are compassionate, tough-minded yet fair. Having promised all that, we must now deliver. In order for us to do so we must receive manuscripts, especially from those areas which have been under-represented in the first four volumes of Aggressive Behavior.

I look forward to continued success of the Journal, so capably published by Alan Liss and his staff. Remember that membership in ISRA decreases the cost of your subscription substantially.

Ronald Baenninger
Editor-in-Chief

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AGGRESSIVE BEHAVIOR
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# Aggressive Behavior of Pigeons
## Suppression by Archistriatal Lesions

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The agonistic responses of pigeons to the introduction of a stick and the experimenter s hand into their home cages is described The effects of lesions of the archistriatum a presumed homologue of the mammalian amygdala of lesions of the overlying neostriatum and of control sham operations on this behavior in selected aggressive pigeons are reported Only archistriatal lesions lead to a persistent depression of the aggressive and a converse increment of the avoidance components of the pigeon s response to both test stimuli The results are discussed in relation to other evidence on the role of the avian archistriatum and this structure s correspondence with the amygdala

ey words pigeon archistriatum intra/interspecific aggression

## INTRODUCTION

Ethological studies show that the aggressive behavior of animals serves a variety of functions depending on the socio-ecological niche occupied by each species Accordingly it can be expected that the physiological mechanisms controlling aggression will differ from species to species A common phyletic origin may conversely have caused the retention of similar patterns of control It is obvious that comparative studies on the physiological basis of aggression are needed to assess the effect

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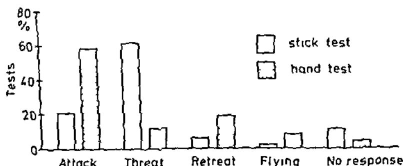
sequel is aggression Freezing is a fear response that will often develop from the attentive response the animal simply becoming immobile and remaining so for a period varying between several seconds and minutes before slowly beginning to make small amplitude movements or before suddenly exploding into extreme flight behavior From attention or such unfreezing pigeons often progress to leaning away that is *bending the body and head away from the stimulus with a sidewards orientation* without shifting and while observing the stimulus intently In this position it may hold out the wing closer to the stimulus wing fending This may lead to withdrawing that is *walking away mostly with a sideward attitude* to the stimulus and attempting frantically to leave the cage pushing against the wire netting Attempts to fly away may then be observed the birds extending and flapping the wings and pushing against the cage walls This active flight behavior is sometimes though not often preceded by alarm calls harsh notes transcribable as hinnh A variant style of avoidance and escape is crouching when the pigeon presses the body against the floor the wings drooping slightly and the neck retracted and sneaking where it crawls away maintaining this posture

A distant stimulus often elicits bow-cooing that is walking tracing a series of reversing semicircles with the plumage fluffed the tail spread and the throat swollen with interspersed brief bursts of speed and body and head bows while giving repeated calls cooo-cooo If the stimulus approaches the animal will usually revert to threat The animal fluffs the plumage sometimes also spreads the tail and swells the throat maintaining a sidewards orientation to the stimulus The wing opposite to the stimulus is raised above the back that close to the stimulus is flicked or more rarely also raised This may lead to attack where the animal approaches the stimulus sometimes jumping forward and slapping with the wing close to the stimulus exceptionally with both wings raising them and bringing them down sharply on it It will also peck most short of target but sometimes gripping the stimulus vigorously shaking or twisting it with the eyes closed A deep throated aggressive vocalization may accompany this behavior

For the final routine scoring the response of a pigeon to a stick or hand test was classed as either attack threat retreat or flying away depending on the response predominantly shown by the subject In the great majority of the tests there was no difficulty in deciding between the categories The interobserver agreement was of the order of 95% Additionally we also noted which of the behavior elements described above were shown during each test component Later in the text we will also often refer to aggressive and avoidance behavior these categories simply refer to attack and threat and retreat and flying away respectively taken together

We compared the efficacy with which the two stimuli used stick and hand elicited aggressive responses from the initial 75 animals not yet selected for predominant aggressive responding The stick elicited more agonistic responses than the hand in only 5% of the pigeons while the hand did so more than the stick in 84% of the subjects the remainder of the subjects reacting similarly to both

stimuli Figure 1 shows that the tests with two stimuli elicited different response profiles The hand released relatively more attack retreat and flying away scores than the stick which yielded predominantly threat while relatively few tests yielded no agonistic responses at all




ig 1 Agonistic behavior shown by pigeons (N = 75) in response to a stick and a hand introduced into their home cages

.esions

The examination of the histological sections revealed differences in the location nd extent of the lesions in the 12 experimental animals This made it necessary to lass them into three groups three subjects had bilateral lesions in the archistria um three others had only unilateral lesions in the same structure (it is possible hat very small contralateral lesions might have passed undetected) six subjects ad bilateral lesions that largely spared the archistriatum and mainly affected the overlying neostriatum caudale (Fig 2) Additionally there were six subjects in the control group that had undergone a sham operation their brains were histolog ically normal

Comparing in each case the percentage response scores on both the stick and the hand tests four weeks preoperatively and five weeks postoperatively reveals that both the bilateral and the unilateral archistriatally damaged animals showed reason ably similar decrease in aggressive behavior and increase in avoidance behavior (Fig 3) Thus warranted lumping them together into a single group of archistriatals Due to chance several subjects with preoperatively less marked aggressive and more pro nounced avoidance behavior were included in this group Nevertheless all the archi striatally lesioned pigeons showed a postoperative decrease in aggression and an in crease in avoidance behavior The animals with neostriatal lesions showed no

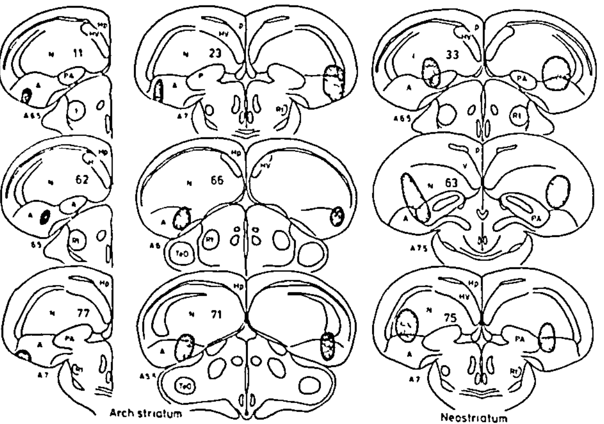



Fig. Location of the archistriatal and neostriatal brain lesions. Only a sample of neostriatal lesions is shown; the three remaining pigeons had similar lesions. Numbers identify the subjects.

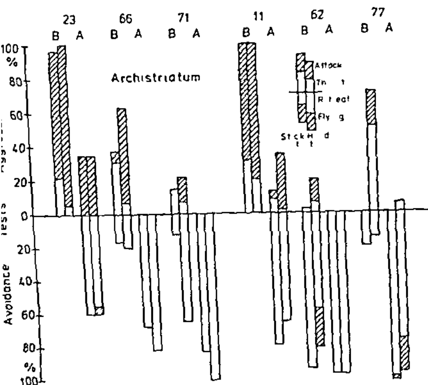



Fig 3 Agonistic behavior shown by pigeons during tests before (B) and after (A) lesions of archistriatum Numbers identify individual subjects

change in behavior unless it was a slight average increase in aggression (Fig 4) The control subjects overall similarly did not show changes except that one animal (No 16) yielded an unexplained delayed and transitory postoperative decrease in aggression and increase in avoidance (Fig 5)

Figure 6 illustrates the mean results of all three groups Comparison of the pre operative with the postoperative behavior separetely for the stick and the hand tests reveals that only the archistriatally lesioned animals showed significant changes The decrease in aggression in the hand test was significant at $P < 0.01$ ($t = 5.43$ $df = 5$) The increase in avoidance was significant for both the stick test ($t = 4.92$ $df = 5$) and the hand test ($t = 5.59$ $df = 5$) at $P < 0.01$

The nature of the response changes in the archistriatally lesioned animals is shown in more detail in Figure 7 Excepting some of the more rarely occurring patterns for which the evidence is not clear all other patterns showed changes compatible with the overall conclusion that the lesions produced a decrease in aggressive and an

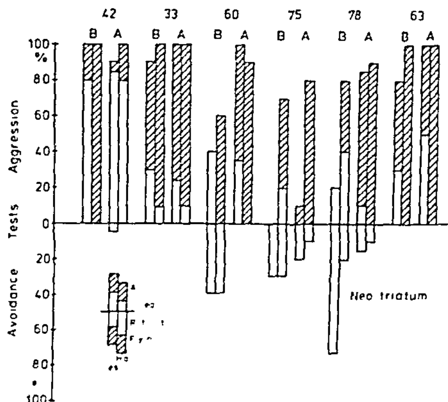



Fig. 4 Ag  ist  beha  r shown by pi eons during tests before (B) and after (A) lesions of t e ne s ria um Numbers iden  y indi idual subj cts.

increase in avoidance behavior In particular pecking and wing slapping decreased and l aning away and  rou hing increased as a consequence of partial ablations of th archistriatum However the effe ts of the archistriatal lesions on the agonisti be havior may not be permanent Fi ure 6 shows that by the sixth postoperative we k th subj ts responses parti ularly the ag essive components returned some way towards p eoperative l vels We do not have sufficient data available to decid whe th r the time until re overy is dependent on the s ze of the les on but this seems po sibl S n e th  l stolog showed that the les ons were filled with glial scar tissue n capabl of neural fun ti n  it must be con luded that other neural ti u  mu  have been respons bl fo th s re overy

R gard ng food con umption there was only a rather slight d fferen e between a h s ria ally l sioned and th controls (unl sion d and n ostriatally les oned) but both groups sh wed a trans ory about 10% d rease in food intake after the in ven i n  th s d eased intake may have been more p o on d in the arch striatal a mals th ee weeks) than in the controls (two weeks) Th s difference did not sh w up in th b dy w h s wh h in reased s ea ly in bo h g oups by about 5% in th of e  weeks of  s rat n

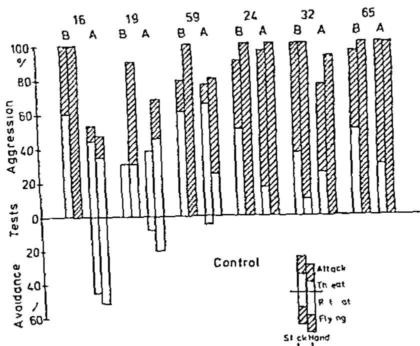



Fig 5 Agonistic behavior shown by pigeons during tests before (B) and after (A) control sham operations Numbers identify individual subjects

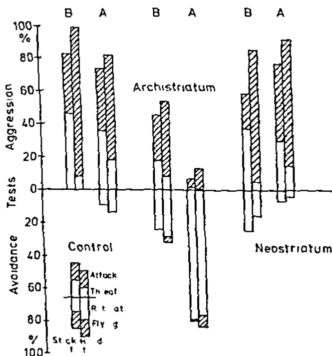
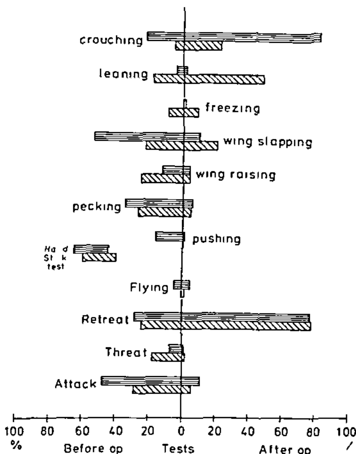



Fig 6 Mean agonistic behavior shown by pigeons (N = 6 in each group) during tests before (B) and after (A) archistriatal or neostriatal lesions and sham control operations.




Fi 7 Comparison of pre and postoperative a onistic behavior of archistriatally lesioned pi eons (N = 6)

## DISCUSSION

Agonistic behavior is shown by animals in many different functional contexts It may address members of other species as part of predatory behavior as an anti predator response as a defense against parasites or as a reaction against ecological competitors As a response to conspecifics it may function to secure or defend re sources (including social partners) or to support or prevent intraspecific predation or even to reject diseased individuals While the behaviors shown in these various s tuations by a given species may be qualitatively different they often overlap The functional context of the agonistic responses elicited by our testing procedures is

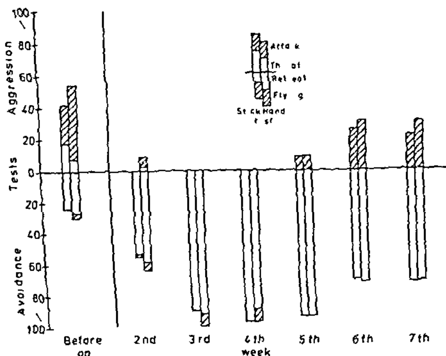



Fig. 8 Time course of agonistic behavior changes after archistriatal lesions in pigeons. Mean of six subjects

probably complex On the one hand it may be understood as an interspecific anti predator behavior as indicated by the occurrence of freezing crouching and sneak ing responses shown in the wild toward predators but rarely against conspecifics [Delius unpublished observations] on the other hand there are indications that this domestic species considers man to some extent as a conspecific much as im printed geese do their caretaker This is suggested by the occurrence of bow-coo ing a response that is not shown toward natural predators by pigeons but is very frequent in intraspecific social encounters both agonistic and sexual Our tests may thus assay a functionally heterogenous set of behaviors that conceivably could al so involve different control substrates

These considerations however will provisionally be subordinate in view of the simplicity and relative reliability of the tests Their usefulness is justified by the re sults Lesions located in the archistriatum markedly and significantly depress the aggressive responses in favor of a predominance of avoidance behavior as measured by the tests Lesions in the neostriatum do not have this effect rather there may

be a slight though nonsignificant increase in aggressive behavior Note that this group of animals provided a blind control group since only the histology revealed that the intended archistriatal lesion had been misplaced Control sham operated animals did not show any significant change

The reduction in aggression and increase in avoidance following archistriatal le sions contrasts somewhat with results obtained on birds by other authors Phillips [1964] reported taming as the main consequence of ventromedial archistriatum and tractus occipito mesencephalicus lesions in mallards (Anas platyrhynchos) the tract being the main efferent pathway of the archistriatum The descriptions seem to suggest that taming consisted principally of a reduction of fear responses elicited by man He also obtained comparable results with similarly lesioned lovebirds (Agapornis roseiecolis) fear inducing objects were less effective in suppressing feed ing However there was also reduction in mobbing behavior toward such objects mobbing being perhaps a partially aggressive response [Phillips 1968] Zeier [1968] refers to the taming effect of more lateral archistriatal lesions in pigeons (correspond ing more closely to ours) but does not specify of what this taming consisted Antero lateral lesions seemed to increase fearfulness occasionally aggressiveness [Zeier 197 Maser et al [1973] report that archistriatal lesions in chickens (Gallus gallus) facili tate the tonic immobility response that we think to be related to freezing behavior an avoidance response Dafters [1975 1976] reports a learning deficit in archistria tally lesioned pigeons when an aversive reinforcer was used [compare also Cohen 1975] Wright and Spencer [1976] found that ring doves (Streptopelia risoria) with tractus occipito mesencephalicus transections virtually ceased to show any kind of agonistic behavior to a predator model

It does indeed not seem possible to ascribe consistently to the archistriatum an aggression facilitating avoidance suppressive function Several factors may be respon sible for the apparent diversity in the results of these various studies variations in lesion extent and location species differences and heterogeneous behavioral assess ment In our case we also wonder whether the selective use of aggressive animals might not have biased the results Elsewhere one of us has argued that the same neu ral substrates might have different functions in the control of fear and aggression in individuals with either fearful or aggressive dispositions [Delius 1973] Could it be that the same lesion might suppress aggression and facilitate avoidance in an aggressive subject but have the reverse effect in a fearful one?

Collation of information from electrical brain stimulation studies on various avian species suggests that indeed the bird s archistriatum among other structures is a control substrate for both aggression and avoidance responses [Akerman 1966 pigeons Maley 1969 Phillips 1964 mallard Putkonen 1966 1967 1973 Phil lips and Youngren 1971 chicken Vowles and Beazley 1974 ring doves] Though not decisively these heterogeneous data seems to indicate that the aggressive respon ses are obtained predominantly from the ventromedial part of the archistriatum where as avoidance responses are elicited from more dorsolateral parts of the structure

Such a differentiation in function might relate to the regional connectivity differentiation that Zeier and Karten [1971] have established for subdivisions of the pigeon s archistriatum [see also Zeier and Karten 1973 Kondo 1933 chicken] Our lesion data are insufficient to allow conclusions as to correlations between the intersubject behavior defect differences and the rather small variations in lesion placement That is an issue that must be pursued in further work The feasibility of such an analysis is suggested by the fact that small lesions only affecting reduced portions of the archistriatum yielded clearcut behavioral effects A remarkable finding is that unilateral archistriatal lesions and small ones at that seem just as effective in reducing aggression as bilateral lesions As a rule unilateral lesions lead to lesser and sometimes hardly detectable behavioral defects as compared with symmetric lesions There are cases however in which the effect of such lesions is more marked than that of bilateral ablations An example is unilateral hemispherectomy in the chaffinch (Fringilla coelebs) that leads to a predator mobbing response deficit to stimuli viewed with the contralateral eye An equivalent deficit is not apparent with symmetric lesions [Strata 1964] The phenomenon may apply to the archistriatum since Kalisher [1905] reports a contralateral visual agnosia following unilateral lesions of this structure in parrots (Psittacidae sp) However we did not notice such a lateralization effect Aggressive responses to the test stimuli were reduced seemingly no matter with which eye the animal viewed them but admittedly no detailed attention was given to this point

It remains to comment on the absence of marked alteration of the feeding behavior of the archistriatally lesioned animals as compared with their controls Archistriatal lesions in pigeons have been reported to lead to temporary aphagia by Zeigler et al [1969] This fits with the archistriatum anterior being a projection of the nucleus basalis a structure that undoubtedly plays a role in controlling food uptake responses [Zeigler 1976] Our lesions almost certainly spared the relevant portion of the archistriatum and this may explain the slightness of the feeding deficit we obtained The homology of the avian archistriatum and the mammalian amygdala is supported in a general way by the results of lesions and stimulation experiments in birds The behavioral syndromes obtained correspond to those often found in equivalent studies in mammals Amygdala lesions have variously affected aggressive and avoidance behavior [eg Kaada 1972] food intake [eg Fonberg 1974 Box and Mogenson 1975] and predatory behavior [eg Zagrodzka and Fonberg 1977 Karli et al 1977] Stimulation on the other hand has been shown to elicit or at least facilitate aggression avoidance [eg Fernandez de Molina and Hunsperger 1962 Delgado 1967] predatory aggression [eg Egger and Flynn 1963] and feeding [eg Fonberg and Delgado 1961 Lewinska 1968] A recurring theme in these studies however is the functional differentiation of the amygdala in some cases coinciding with recognizable anatomical subdivisions It is premature to relate this to the situation in birds Zeier and Karten [1971 1973] have shown that the archistriatum is differentiated anatomically and actually they argue that the more lateral and anterior portions

may not be homologous to the mammalian amygdala at all The lesion and stimulation work described above contains some indications of a corresponding functional differentiation but the information available does not yet fit into a coherent pattern

## ACKNOWLEDGMENTS

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# Rank and Reproduction Among Female Langur Monkeys Aging and Improvement (They're Not Just Getting Older, They're Getting Better)

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An investigation of the social rank reproduction and ages of adult female Indian gray langur monkeys (Presbytis entellus) living in two colony social groups revealed that rank based on displacements is neither correlated with nor best predicted by female age or reproductive value The hierarchy of female ranks is best conceptualized as a layered ranking system in which there are clusters of females of the same dominance rank forming layers within the structure Statistical significance in frequencies of displacement differs between but not within these layered groups of females Factors such as group composition presence of uterine kin, reproductive state and individual personality are hypothesized to predict changes in female rank far better than does reproductive value Our data show that reproductive success increases with age The infant survival record for the six oldest females in our colony was much better than for the five youngest adult females

Key words langur monkey aggression dominance reproduction selection age

## INTRODUCTION

For several decades the social behavior of Old World monkeys and apes has been scrutinized by investigators from several disciplines many seeking models

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of human evolution and illustrations of natural selection including kin and sexual selection It has been known for many years that rank among males is im portant for reproductive success and hence for evolution Yet it has only been in the last few years that investigators have called attention to the possible im portance of social rank for the reproductive success of females [Missakian 1972 Drickamer 1974 Blaffer Hrdy and Hrdy 1976 Blaffer Hrdy 1976 1977 Deag 1977] Earlier stages of primate research on baboons and macaques and particularly on the conspicuous males of some species produced a premature and over simplified picture not only of female behavior [Beach 1976] but also of primate behavior in general [Bernstein 1970 1976] Social structure was conceptualized as rather uniform and to a large extent dependent upon social hierarchies which in turn promote the fitness of only the highest ranking individu [Rowell 1972] The relationship between rank and reproduction even among males appears to be ambiguous and much more complex than anticipated by early researchers [Hausfadter 1975]

The purpose of this paper is to explore the relationships between age repro ductive value reproductive success and social rank among female Indian langur monkeys (Presbytis entellus) At the same time we propose to call attention to special characteristics of the subfamily to which langurs belong the Colobinae The Colobines or the leaf-eating monkeys are indeed the other half of the Old World monkeys and the subfamily encompasses as many genera and species as the well known Cercopithecinae and of the two the Colobines may prove to be the most variable Langur social organizations and structures are extremely flexible insomuch as both multi male one male bisexual and unisexual groups may be found within a local population Jay [1963] and Yoshiba [1968] stress that langur society is quite sensitive to its immediate environmental conditions an Curtin [1977] discusses in what specific ways this sensitivity can be expressed Our data suggest that among female langurs relationships between rank age and reproduction are neither simple nor readily apparent Based upon data from a study of two well constituted captive groups it was found that ranking female langur monkeys in a linear manner as though they were on rungs of a ladder obscured very important information about the nature of langur social structure For example younger females frequently become actively involved in displace ment a behavior traditionally associated with dominance or high rank but they are not highly successful In contrast the most dominant females acted least frequently in dominance displacements but almost always more successfully than their often younger associates Furthermore while it can be said that younger females have potentially higher but not yet proven reproductive values due to their age in our study groups older females (multipara) produce almost twice the number of viable offspring as young primiparous females Data from field studies of free ranging langur monkeys support these conclusions [Jay 1963 Curtin 1975 Boggess 1976] It appears that the attainment and expression of an

individual s social rank is exceedingly complex sometimes subtly and/or infre qu ntly exhibited and may change within (relatively) short periods of time A female s social rank is sensitive to events in her reproductive cycle and to the processes of aging There are many strands to a social rank — far more than are reflected by for example contests between animals stimulated or elicited by the human observer[7] Among many Cercopithecines but less so for Colobines the system of rank relations among group members is an obvious component of the group social structure and is furthermore vital to the life strategies of individual animals

## SUBJECTS METHODS AND PROCEDURES

This study was undertaken at the University of California (Berkeley) Animal Behavior Station and is based upon 311 hours of observation of females living in stable social groups which include some but not all close relatives Issues raised in field work by Jay [1963 and unpublished data] Blaffer Hrdy [1977] Curtin [1975] Boggess [1976] and a considerable amount of colony data (over 4 000 observation hours at Berkeley and 1,500 in San Diego by McKenna [1975]) prompt us to address the phenomenon of social rank among females To this end a subset of detailed focal animal samples of eleven colony living females (six feral or Indian born five captive-born) were examined Data were collected over a continuous eight month period using focal animal samples ten minutes in length A standardized behavioral repertoire and recording technique were employed by trained observers whose inter-observer reliability was greater than 0.95 Each of the groups con taining our subject females included an adult male and immature individuals of both sexes

The purpose of this study was to examine the concept of social rank among female langurs and to investigate the relationship between social rank age and reproduction Two rank orders were established for females in each group One set of ranks was based upon the sum total of displacements and move aways two dominance related behaviors In the data analysis these two behavior items are combined and called displacements A female (animal X) was said to displace another (animal Y) if upon her approaching female Y and after establishing visual or tactile contact female Y departs giving up to female X her previously held physical space or some other identifiable resource such as a food item or grooming partner On those occasions when it was difficult to make a judgment as to the animal s intent or motivation and hence the displacement was ambiguous a be havior category called a move away was used A female X was said to move away from female Y if upon some social stimulus such as the approach of Y female X departs from Y but without Y s subsequent appropriation of X s space or resource To determine whether our displacement move away-based ranking system reflected actual rank relationships nine aggressive behavior items — bite chase hand threat

hand threat with contact face threat glare threat slap ground lunge threat and nonsexual harassment – were added to the sum totals of displacment and move aways received and initiated by each of the females of both groups A second set of ranks which included these dominance related aggressive behaviors was thereby constructed and then compared with the ranks based only upon our nonobserver provoked displacements and move aways There were no differences between the two sets of ranks Hence for comparative purposes we chose to work only with our displacement based ranks It should be noted that when individuals moved inde pendently of particular social stimuli as for example when a female departed from a relaxed resting cluster other behavior units (horizontal departure or vertical de parture) were used and were not included as measures of rank

Over 1 800 ten minute focal samples were analyzed These samples were key punched and analyzed by an ALGOL computer program specially designed to tabulate frequencies of occurrences actors receivers and participants in inter actions DGS E C I P S E computer system using R D O S was employed To determine possible statistically significant differences between assigned ranks T tests at the 0 001 confidence level were used as well as regression coefficients

Since the age of female langurs is critical in testing hypotheses of female reproductive strategies involving fitness [Blaffer Hdry 1976 1977] it is im portant whenever possible to present confirmed and reliable age data A number of external and easily observed physical characteristics including depth and quality of facial creases extent of facial and skin wrinkling (particularly around the nose) teeth wear and nipple and lip form have been used to approximate the age of subjects [Blaffer Hrdy 1977 72–76] While some of these criteria have be used by other investigators to assess general but not specific age [Jay 1963] tremendous inter individual variability in any one of these traits makes differ entiating between for example old and middle aged [Blaffer Hrdy 1977] females living in the field a very subjective and inexact procedure A captive setting provides both a controlled environment for quantification of behavior and an opportunity to obtain records important for testing possible relationships between age and other phenomena such as status and reproduction

The exact age of five of our subject females is known from birth records and estimates were made on the remaining six feral born females It is very likely that the ages of females D E F G H and K range between 13 and 25 years of age for at the time of their importation in 1972 their weights indicated adult hood and their physical characteristics suggested sexual maturity and multiparity However to avoid the possibility of serious error a very conservative estimation of the ages of these Indian born females based upon an estimated average age of four at first conception is thirteen years It is likely that these females are in fact many years older

**TABLE I** Displacement Rank, Age, Birth Records, and Number of Minutes Each Female Was Observed in This Study*

| Group 1 | | | | | Group 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rank over 6 mos | Ss | Age in years | Total births (surviving) | Focal minutes | Rank over 8 mos | Ss | Age in years | Total births (surviving) | Focal minutes |
| 1 | A | 9 | 3 (2) | 1 050 | 1 | G | > 13 | 1 (1) | 2 380 |
| 2 | B | 7 | 2 (2) | 1 900 | 2 | H | > 13 | 3 (2) | 2 920 |
| 3 | C | 4 | 1 (0) | 1 370 | 3 | I | 7 | 3 (0) | 2 930 |
| 4 | D | > 13 | 2 (2) | 1 080 | 4 | J | 7 5 | 2 (1) | 820 |
| 5 | E | > 13 | 0 (0) | 1 100 | 5 | K | > 13 | 2 (?) | 2 350 |
| 6 | F | > 13 | 3 (3) | 780 | | | | | |
| | | Total sample minutes 7 280 | | | | | Total sample minutes | | 11 390 |

*Females are ranked by minimizing the number of times a female is displaced by females ranked beneath her

**TABLE IIa Displacement Matrix – Group 1**

| | | Displaces Ss | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rank | Ss | A | B | C | D | E | F | Total displacements |
| 1 | A | – | 10 | 5 | 12 | 12 | 17 | 56 |
| 2 | B | 7 | – | 17 | 11 | 23 | 31 | 89 |
| 3 | C | 4 | 13 | – | 12 | 39 | 33 | 101 |
| 4 | D | 2 | 6 | 14 | – | 8 | 11 | 41 |
| 5 | E | 4 | 3 | 14 | 8 | – | 14 | 43 |
| 6 | F | 3 | 6 | 16 | 5 | 7 | – | 37 |
| Total number of times displaced | | 20 | 38 | 66 | 48 | 89 | 106 | 365 |

**TABLE IIb Displacement matrix – Group 2**

| | | Displaces Ss | | | | | |
|---|---|---|---|---|---|---|---|
| Rank | Ss | G | H | I | J | K | Total displacements |
| 1 | G | – | 23 | 60 | 31 | 62 | 176 |
| 2 | H | 7 | – | 26 | 15 | 39 | 87 |
| 3 | I | 23 | 18 | – | 23 | 71 | 135 |
| 4 | J | 8 | 3 | 2 | – | 8 | 21 |
| 5 | K | 5 | 13 | 14 | 4 | – | 46 |
| Total number of times displaced | | 53 | 57 | 102 | 73 | 180 | 465 |

## RESULTS

Table I presents ranks based upon displacement data with age and the birth records of females of groups 1 and 2 Tables IIa and IIb show the actual displace ment matrices Table III summarizes and compares ranks based upon displace ments with ranks based upon age reproductive history and percent involvement in displacement activities A total of 1 830 female female displacements were recorded and these constituted approximately 507 of the total displacements in which adult females were involved The other 50% involved females with males or infants It is very important to note that none of these displacements were obser provoked An analysis of the data shows the youngest females in each group (C and I) occupied middle displacement ranks had the poorest birth records and were engaged in the highest and next to highest frequency of female female dis

TABLE III Rank Ordering for the Adult Females of Two Groups

| Rank | Displacement | Age | Birth records | Involvement |
|---|---|---|---|---|
| | | | Group 1 | |
| 1 | A | F D E | F | C |
| 2 | B | | D B | F |
| 3 | C | | | E |
| 4 | D | A | A | B |
| 5 | E | B | E | D |
| 6 | F | C | C | A |
| | | | Group 2 | |
| 1 | G | G H K | K | I |
| 2 | H | | G H | G |
| 3 | I | | | K |
| 4 | J | J | J | H |
| 5 | K | I | I | J |

Each column represents an order from most to least dominant according to the criterion at the top of the column Rank one indicates in column 1 most dominant in column 2 oldest in column 3 best birth records and in column 4 most frequent involvement in displacement

placement activities The oldest females occupied a range of displacement ranks varying from rank 1 (G) to the lowest ranks in both groups (F and K) Further more as defined by the number of surviving infants produced the oldest females in each of the groups experienced the greatest success as seen in Table III

Several interesting difficulties arising from constructing a linear displacement based ranking system demonstrate the unprofitable nature of such a unistrand approach to understanding langur female rank behavior For example the data show that among related females A C and D mother D displaced her younger daughter C more often than C displaced her (D) and the oldest daughter A dis plac d all others most often Yet mother D according to a displacement based system is ranked under her daughter C because C a very active displacer had high frequencies of displa ement with females E and F In other words because daughter C engaged in more dominance related behaviors with respect to other females she succeeds her mother s rank position The mother interacted less frequently than did her daughter but her success rate is much greater Arranging female displacement ranks linearly obscures the fact that females A B C and females D E F form two dominance layers in which statistical significance in frequencies of displacements differs between but not within these subsets Similarly for Group 2 dominance layer G H and I can be statistically differentiated from layer J K

The most accurate diagrammatic representation of female langur rank re sembles a layered cake Inasmuch as no statistical differences in displacement rates separate animal A from B and animal B from C they share one dominance layer A student T test at the 0 001 level reveals significant differences between displacement frequencies between C and D but statistically significant differ ences do not exist between D E and F Therefore a synthesis of the relationships between these sets of displacement data indicates two major dominance layers – females A B and C share one layer the top one while females D E and F share another – in this case the second or lower of only two layers More layers have been observed in free ranging troops with a larger number of adult female members [Jay 1963] As stated earlier the same statistical differences separate females G H and I from J and K in the second group

Data collected on two females who gave birth during the present study demon strate that reproductive state does affect rank when it is defined according to dis placement data For example an analysis of pre and postparturition data on female G shows that before giving birth she was involved in 1 78 displacement bouts per ten minute focal sample (n = 1 430) with all members of her group With respect only to females she was involved in an average of 2 15 female female displacements per focal sample After giving birth she was involved in significantly less ($\chi^2 < P$ 001) or 0 42 female female displacements Most im portantly while female G was actively dominant she suceeded in displacing 2 72 females per sample prior to parturition The general effect was that while female G occupied top rank in group 2 before giving birth she shared the top rank with female L after parturition Similarly for female B in group 1 there was a noticeable drop in the frequency of her participation in dominant related activities post parturition

The younger primparous females of the Berkeley colony have high infant mortality rates comparable to the mortality figures presented by Drickamer [1974] for rhesus macaques Based on birth records of 22 pregnancies during the years when all but one of the adult females conceived since 1974 it appears that re productive success increases with age The six oldest females in our colony for example although not more fertile delivered a larger number of viable infants (1 loss of 11 births) than the five youngest females (6 losses of 11 births) Since 197? when the colony was established the older females all wild born have delivered 1 nonviable and 18 viable infants This is a 5% loss of neonates The results strongly suggest that langurs do not differ in fecundity rates from rhesus macaques of which up to 45% of first and second born infants of young females die [Drickamer 1974]

## DISCUSSION

The interpretation of female langur behavior is currently the subject of major controversy – specifically the relationship between reproductive value and fit ness age and social rank Blaffer Hrdy [1977] and others assert that a decline in

reproductive value of female langurs occurs with increasing age and is associated with a corresponding decline in rank The reproductive value for old females is not only very low but these females no longer vigorously contest dominance with younger females (presumed by Blaffer Hrdy to be kin) because the older females inclusive fitness benefits are greater if resources are allocated to their younger presumably more fertile kin According to this view age best predicts the direction of rank changes with younger females rapidly assuming top ranking positions at the expense of the older troop females Old low-dominance ranked females are viewed as still fierce in non-dominance contests such as defense of the troop against domestic dogs or the approach of nontroop adult males

Two assumptions in the above need to be questioned 1) That old age confers drastically reduced reproductive value and 2) that old age results in lowered dominance status According to Blaffer Hrdy and Hrdy [1976 915] old females have less to lose from risk taking in terms of future reproduction than do younger animals An example is given of an old female defending an infant at best her granddaughter while the infant s mother remains inactive The mother s inactivity suggests that the benefit to recipient/cost to altruist ratio is very low The reproductive value risked by the old female is assumed to be very low indeed Our data from the colony and other data from the field indicate that the reproductive abilities of even quite old females are substantial It is our contention that few female langurs survive to even close to menopausal age in the rigors of the field and that the estimates of age employed by Blaffer Hrdy are inadequate For the model proposed by Blaffer Hrdy and Hrdy [1976] to work it is essential that the older females are really as old as 25 26 or 27 and that they have ceased to reproduce successfully As of the present and in terms of langur data it has not been shown at what age if any langurs experience menopause If there proves to be subgroups of post menopausal females in langur troops then the idea that these females defer to younger females may be understood in the context of fitness models However if older females continue to reproduce as successfully as our data would indicate then there would seem to be few if any definite advantage

Aside from these criticisms Blaffer Hrdy and Hrdy s contention that differences in reproduction at different ages are due to fecundity differences and not mortality may be questioned because of the intermittent nature of their observations When behavior is not monitored throughout the year it is possible to miss births One may make statements about surviving infants with some reliability but not about the numbers of infants born

The second major issue centers on the assertion that old age results in lowered dominance and once again our data do not indicate that this is the case The evidence for this is presented in Tables I II and III Clearly age is not a useful predictor of displacement rank reproductive success or degree of involvement in agonistic interactions except for individuals of very great age or females who survive to menopausal age Nowhere is the role of individual personality or temperament

clearer than in dominance behavior but unfortunately both of these variables are hard to measure Inclination to interact varies tremendously among adult females — from low to high regardless of age It is not the number of times an animal attempts to dominate as much as the frequency of success that counts in establishin priority of access to desired commodities animals or places among the females of the troop Preferences in association express themselves in dominance interactions *with certain females constantly interacting with some but not others in the* troop Adult females do not give preferential treatment to related animals after the latter reach adulthood

On the basis of five two to three month observation periods separated by gaps of up to fourteen months Blaffer Hrdy maintains that the outcomes of displacement interactions were predictable on a day to-day basis but not necessarily *constant between study periods* [1977 165] *This statement is not surprising in* view of the long gaps between short observation periods Data from captive and most field locations indicate that female displacement based rank fluctuates in concordance with changes in reproductive cycles and the rearing of young It was possible to predict rank change based upon age for at least two of the Abu troops Our data however permit no such prediction and in fact show that both older and younger females can be found intermixed in ranking order In addition irrespective of age ranks change

If the captive setting has an effect upon the type of data retrieved most likely it is an increase in the chances that relatively stable hierarchies among females could be observed and defined Similarly the effect might also be to enhance the utility of measuring aggressive displacements to determine rank and ultimately to determine who could reproduce Rowell [1972] and others have pointed out that reducing space tends to facilitate the emergence of hierarchies but certainly does not tend to diminish them Yet it is in only a few field locations rather than in the laboratory that data support the construction of linear hierarchies for female langurs Many field studies of common langurs corroborate our view of rank as minimally important in female day to-day life [Boggess 1975 Sugiyama 1976 Jay 1963]

## SUMMARY

The picture emerging from our colony study of female langur behavior indicates that rank based on displacements is neither correlated with nor best predicted by female age or reproductive value A composite of factors such as group composition presence of uterine kin reproductive state and individual personality are hypothesized to predict changes in female rank far better than does reproductive value a concept directly related to female age There is a positive relationship between increasing age and successful reproduction The notion of linear ranking is not useful to the understanding of langur female behavior and elucidates

nportant *differences between these Colobine* leaf-eating monkeys and the nore nepotistic and sometimes dominance-oriented Cercopithecines For the latter ocial rank may correlate with reproductive success [Smuts 1972 Deag 1977 Dnckamer 1974] The net result of further exploring the versatile Colobines is to obtain a broader understanding of primate behavior and to secure data that may be used with caution in interpreting the specific and general mechanisms of natural selection and evolutionary change

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AGGRESSIVE BEHAVIOR
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# Alterations in Shock-Induced Fighting and Locomotor Activity Following Intracerebroventricular Injection of Hydrocortisone in the Rat

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Three experiments were conducted in an attempt to clarify the facilitatory influence of hydrocortisone on shock-induced fighting in rats Results of the first experiment indicated a biphasic dose-dependent action of intraventricularly administered hydrocortisone Low (25 μg) and intermediate (50 μg) doses both facilitated fighting whilst the high (100 μg) dose exerted a potent suppressant effect. Two control tests were performed to determine whether alterations in pain reactivity or locomotor activity could have accounted for the observed changes in fighting behaviour None of the treatments altered shock thresholds (Experiment 2) but whilst neither low nor intermediate doses affected activity measures, the high dose preferentially reduced vertical activity (Experiment 3)

Key words shock induced fighting activity pain thresholds hydrocortisone rats

## INTRODUCTION

Over the past decade considerable experimental evidence has accumulated for pituitary adrenocortical involvement in agonistic behaviour [Brain 1972 Leshner 1975] Bilateral adrenalectomy reduces isolation induced fighting in mice [Brain et al 1971 Harding and Leshner 1972 Leshner et al 1973] an effect also observed following hypophysectomy [Sigg et al 1966] Corticotrophin (ACTH) acts

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differently on fighting behaviour according to treatment regimen Chronic administration of ACTH suppresses isolation induced fighting in mice [Brain et al 1971 Brain and Poole 1974 Leshner et al 1973 Poole and Brain 1975a] whilst acute ACTH treatment augments this behaviour [Brain and Evans 1977 Poole and Brain 1975b] Although the former effect appears to correspond to an extra adrenal action of ACTH the latter response has been tentatively related to enhanced glucocorticoid release [Brain and Evans 1977] Glucocorticoid injections (natural and synthetic) have been reported to increase isolation induced fighting [Banerjee 1971 Brain et al 1971 Kostowski et al 1970 Leshner et al 1973] and shock induced fighting [Kostowski 1967] in mice and to restore aggressive behaviour in adrenalectomized mice [Walker and Leshner 1972] This treatment also increases muricidal behaviour [Kostowski 1967] and maternal aggression [Endroczi et al 1958] in rats In spite of this wealth of data it has been argued that corticosterone treatment has no effect on murine aggression independent of its effects on ACTH levels [Leshner et al 1973]

In a recent extension of the above research Rodgers and Semple [1978] reported that shock induced fighting was suppressed by adrenalectomy hypophysectomy and high doses of ACTH In contrast fighting was enhanced by hydrocortisone and low ACTH doses The present report attempted to investigate the facilitative influence of hydrocortisone on shock induced fighting by using intraventricular injections This method has the advantage of ensuring that the hormone reaches brain tissue in significant concentrations thus reducing the possibility of peripherally-mediated behavioural changes Since the frequency of fighting in this paradigm can easily be influenced indirectly two control experiments were performed to assess the possibility of treatment induced alterations in locomotor activity and pain reactivity

## GENERAL METHODS

### Animals and Surgery

Adult male Sprague Dawley rats (260–300 gm) from Bradford University colony were used as subjects Animals were individually housed with food and water available ad libitum and maintained on a 12 hour light/dark cycle (7 am–7 pm) All testing was performed under red light during the dark phase ie 7 pm onwards

Under Equithesin anaesthesia (Jensen Salsbery Lab Inc ) experimental animals were implanted unilaterally with guide cannulae terminating 1 mm dorsal to the right lateral ventricle (A/P – 2.0 L 1.8 V 2.0 mm calculated with reference to Bregma) Cannulae consisted of 23 gauge stainless-steel guides fitted with 31 gauge stylets The animals received a single intramuscular injection of penicillin

(50 000 units) following surgery and were allowed at least seven days recovery before behavioural testing

### Injection Technique and Hormone Doses

During injection stylets were replaced with 31 gauge injection units which extended 1 mm ventral to the guide tips Single unilateral injections were performed whilst the animals were hand held A 10 µl Hamilton microsyringe (model 710N) with a polythene tubing connection to the injection unit was employed to deliver the solutions Ten µl injections were made at a rate of 1 µl/15 seconds with a total injection time of approximately 150 seconds An uptake time of one hour was adopted in the present study to allow for widespread hormone diffusion throughout the ventricular lumen and adjacent tissue

Hydrocortisone sodium succinate (Organon NV Oss Holland) was used in three dose levels (25 µg/10 µl 50 µg/10 µl 100 µg/10 µl) with injection water serving as both hormone solvent and placebo solution Each animal received one injection only and was used only once in behavioural testing

### Histology

Prior to sacrifice experimental animals received a unilateral injection of trypan blue dye (10 µl) into the right lateral ventricle One hour later animals were given an overdose of Nembutal and perfused intracardially with normal saline followed by 10% formal saline Brains were removed hardened in formal saline and sectioned on a freeze microtome In all but three cases (where data were discarded) dye was observed in maximum concentration around the site of injection (ventriculus lateralis) with widespread distribution noted throughout the ventricular system Most notably significant staining was seen at the medial portion of the basal hypothalamus in the area of the median eminence Although these observations do not in any sense quantify hormonal distribution they nevertheless indicate that one hour after unilateral intraventricular injection of a 10 µl volume significant staining occurs throughout the ventricular system and adjacent tissues

### Apparatus

**Shock-induced fighting and flinch jump tests** A modified rat operant station (manipulanda removed flat interface) measuring 23.5 X 22 X 22 cm served as the test chamber The chamber was opaque apart from the perspex door which also served as an observation window An Aim Bioscience shock generator (Model 507) applied electric shock of specified intensity duration and frequency to the grid floor of the test chamber

**Activity test** A square enclosure with plywood floor (90 X 90 cm) and walls (30 cm high) painted flat white was used Embedded in two adjacent walls were

two banks of six red light sources The lower bank was positioned at 3 cm above the floor level (to monitor horizontal activity) with the upper bank at 12 5 cm (to monitor vertical activity) On the opposing walls two banks of six sensors each were arranged to receive light beams from the corresponding sources Sensors from lower and upper banks were connected to separate counters which registered one count each time an appropriate light beam was interrupted

### Procedure

**Shock induced fighting** Operated animals and unoperated stimulus opponents were matched for weight and fighting pairs were randomly assigned to treatment conditions Pairs were placed in the test chamber one hour after intraventricular hormone or placebo injection to the experimental animal after two minutes habituation the animals were exposed to 60 electric shocks delivered to the grid bars (shock intensity 2 mA duration 0 5 sec frequency 6/min) An attack response was recorded when one animal made a directed forward lunge either with the forepaws or the whole body The upright boxing posture itself did not in this study constitute an attack response Only the behaviour of the injected animals was used in data analysis

**Flinch jump test** Pain reactivity was measured using a modification of the flinch jump threshold test (Evans 1961 Rodgers 1977) One hour after either hydrocortisone or placebo injection individual animals were placed in the test chamber where they received six series of eight electric shocks (0 5 sec duration) delivered at ten second intervals to the grid floor Shock series were administered in alternating ascending and descending order with intensities ranging between 0 13 and 1 00 mA in eight steps Jump thresholds (the intensity at which the hind paws leave the grid floor) were recorded for each series and an overall mean value calculated to provide an estimate of pain reactivity

**Activity test** One hour following intraventricular treatment individual animals were placed in the activity box and horizontal activity vertical activity and defecation scores were recorded over a ten minute observation period

In all behavioural tests the apparatus used was cleansed thoroughly after each animal in order to minimize the effects of any olfactory cues from the preceding subjects

## EXPERIMENT 1

This experiment was designed to examine the effect of intraventricular hydrocortisone injection on shock induced fighting Prior to treatment allocation 34 operated animals were weight matched with unoperated stimulus opponents Four treatment condit ons were used placebo (n of pairs = 10) 25 μg hydrocortisone (n = 8) 50 μg hydrocortisone (n = 8) and 100 μg hydrocortisone

(n = 8) One hour following injection each pair was placed in the test chamber and the frequency of fighting behaviour was recorded

**Results**

Results of this experiment are presented in Figure 1 ANOVA revealed an overall significance in attack frequency ($F = 18\ 4$ $F_{999}$ $(3\ 30) = 7\ 05$ $P < 0\ 001$) Statistical follow up using Newman Keuls test for comparison between treatment means indicated that the 25 μg and 50 μg doses of hydrocortisone resulted in significantly increased fighting behaviour ($P < 0\ 01$) compared with placebo treat ment and that the 100 μg dose of hydrocortisone significantly depressed fighting ($P < 0\ 01$) compared with all the other treatments It would thus appear that intra ventricular hydrocortisone produces a dose-dependent biphasic alteration in shock induced fighting in rats Casual observation suggested that whilst animals receiving doses of 25 μg or 50 μg initiated and maintained fight encounters those receiving 100 μg doses did not do so and were more actively engaged in overt avoidance and submissive/defensive behaviours

## EXPERIMENT 2

It is well established that alterations in shock sensitivity can indirectly modify levels of fighting in the present test paradigm [Rodgers 1977] In order to con trol for this possible explanation of the above results a second experiment was conducted in which shock thresholds were estimated under the treatment con ditions employed in Experiment 1 Twenty naive animals equipped with unilateral intraventricular cannulae were randomly assigned to one of four equal treatment

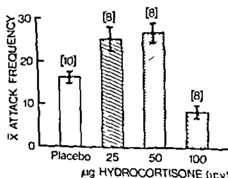



Fig 1 The effects of intraventricular hydrocortisone and placebo injections on attack frequency ($\bar{x} \pm$ SEM) in Experiment 1 Figures in brackets refer to the number of pairs in each condition

groups (placebo 25 50 and 100 μg hydrocortisone) One hour posttreatment each animal was placed in the test chamber and allowed two minutes habituation before reactivity to electric shock was determined using the flinch jump technique

### Results

Results of this experiment are presented in Figure 2 It would seem that hydro cortisone injection at three dose levels does not alter the animal s reactivity to the shock stimulus since ANOVA revealed no overall significance in jump thresholds with treatment ($F = 2\ 99$ $F_{95}$ (3 16) = 3 24 ns)

## EXPERIMENT 3

Another possibility for the results of Experiment 1 is that hormone adminis tration alters motor activity/co-ordination thus indirectly influencing fighting behaviour To test for this possibility 40 naive animals equipped with intra ventricular cannulae were randomly assigned to one of four treatment conditions [placebo (n = 9) 25 μg (n = 10) 50 μg (n = 10) 100 μg (n = 11) hydrocortisone] One hour following treatment individual animals were placed in the activity box and behaviour was recorded over a ten minute session

### Results

Results of this experiment are presented in Figure 3 ANOVA revealed no overall significance either on measures of horizontal activity [$F = 0\ 82$ $F_{95}$(3, 36) = 2 86 ns] or defecation [$F = 1\ 81$ $F_{95}$ (3 36) = 2 86 ns] However ANOVA did reveal significance on vertical activity scores [$F = 7\ 62$ $F_{999}$ (3 36) = 6 74 $P < 0\ 001$] Statistical follow up using Newman Keuls test indicated

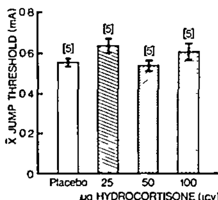



Fig 2 The effects of intraventricular hydrocortisone and placebo injections on shock thresholds ($\bar{x}$ ± SEM) in Experiment 2 Figures in brackets refer to the number of animals in each condition

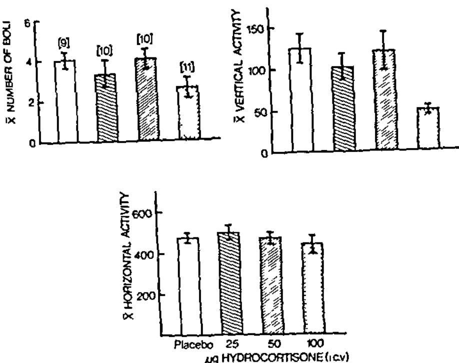



Fig 3 The effects of intraventricular hydrocortisone and placebo injections on three behavioural measures ($\bar{x}$ ± SEM) in Experiment 3 Figures in brackets refer to the number of animals in each condition

that the 100 μg dose hydrocortisone significantly depressed vertical activity compared to placebo ($P < 0\,01$) 25 μg hydrocortisone ($P < 0\,05$) and 50 μg hydrocortisone ($P < 0\,01$)

## DISCUSSION

The results of the present investigation confirm and extend previous observations that glucocorticoids can modify levels of agonistic behaviour in rodents [Banerjee 1971 Brain et al 1971 Brain and Evans 1977 Endroczi et al 1958 Kostowski 1967 Kostowski et al 1970 Leshner et al 1973 Rodgers and Semple 1978 Walker and Leshner 1972] Intraventricular injection of both low (25 μg) and intermediate (50 μg) doses of hydrocortisone facilitated shock induced fighting behaviour in the rat whilst a high dose (100 μg) exerted a potent suppressant effect (Experiment 1) In the dose range currently employed hydrocortisone failed to alter shock thresholds thus eliminating the possibility that the effect on

fighting was indirectly mediated via changes in pain reactivity (Experiment 2) This finding confirms the previous observation that shock thresholds remain unaltered following subcutaneously administered hydrocortisone [Rodgers and Semple 1978] Whilst neither low nor intermediate doses of steroid altered behaviour in the activity test the high dose preferentially decreased vertical activity (Experiment 3) Thus the possibility exists that the reduced levels of fighting at the high dose reflect a diminished ability to form the upright posture characteristic of fighting in this test However casual observation of these animals in Experiment 1 (see Results) indicated that they were capable of forming the posture but that their behaviour was characterized more by in creased avoidance of and submission to the opponent A similar biphasic relationship has previously been reported in murine aggression following peri pheral corticosterone treatment [Candland and Leshner 1974]

Since Erskine and Levine [1973] have reported that complete suppression of pituitary adrenal activity (via implants of hydrocortisone into the median eminence) has little effect on shock induced fighting in this species it is tentatively suggested that the current positive results may reflect an ACTH independent action of the glucocorticoids on neural mechanisms mediating avoidance and attack Indeed the finding that peripherally administered hydrocortisone can restore fighting in hypophysectomized animals to near normal levels (un published observations) would seem to support this suggestion It is of interest to note in this context that McEwen et al [1970] have found that cells within the limbic system (including areas traditionally associated with avoidance and attack) selectively accumulate glucocorticoids

The potentiation of attack produced by both low and intermediate doses of hydrocortisone would appear to contradict the recent suggestion that gluco corticoids are selectively involved in mediating avoidance-of attack [Moyer and Leshner 1976 Nock and Leshner 1976] However it should be emphasized that the present paradigm differs from that of Leshner s group in several im portant respects species (rats vs mice) schedule and route of injection (acute intraventricular vs chronic subcutaneous) and steroid preparation (hydrocortisone vs corticosterone) These methodological differences make a direct comparison of findings difficult We are currently investigating the effects of chronic vs acute intraventricular injections of glucocorticoids (hydrocortisone and corti costerone) on levels of shock induced fighting

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
Volume 5 pages 41–49

# Mousekilling, Intermale Fighting, and Conditioned Emotional Response in Rats

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Several possible relationships between two forms of aggression in rats were studied First mouse killing and spontaneous intermale fighting were found to be correlated Rats which attacked other rats were those most likely to kill mice To determine whether aggressive and nonaggressive rats were also differentially responsive to other situations involving emotional arousal but not aggression mouse killers and nonkillers were compared in a conditioned emotional response (CER) situation Mouse killers showed greater suppression to the conditioned stimulus (CS) and to the situational cues of the apparatus Therefore a common arousal mechanism may underlie a number of diverse agonistic responses Nevertheless extensive mouse killing experience did not increase the tendency of rats to fight with either adult males or juvenile males

Key words rat mouse killing conditioned emotional response interspecies aggression intermale fighting

## INTRODUCTION

Classes or types of aggression (eg predatory intermale irritable) are commonly distinguished either on the basis of their response topography [Clemente et al 1973] or by the stimulus situation in which they occur [Moyer 1968] There is

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also ample evidence that different forms of aggression have different physiologic substrates (see reviews by Clemente et al [1973] and by Moyer [1968]) However such categories should not obscure possible relationships between forms of aggression First the same general laws may apply to each For example familiarity with the stimulus object inhibits instances of predation [Galef 1970a] irritable aggression [Galef 1970b] and intermale fighting [Marler 1976] Second there may be intrasubject correlations A rat which fights frequently in response to shock might also show high levels of spontaneous intermale fighting or mouse killing Finally experience making one type of aggressive response may facilitate other forms of aggression The presence of such relationships would suggest that some common mechanisms underlie different aggressive responses

The experiments reported here examined these three types of possible relationships by comparing mouse killing and intermale fighting in rats Mouse killing is usually classified as predatory aggression (see review by O Boyle [1974]) Predatory attack is evoked by the presence of an appropriate prey object and usually results in the prey s death It is considered to be quite different from intermale fighting [Moyer 1968] which is evoked by the presence of a conspecific involves high arousal and seldom results in the death of either combatant However at least two manipulations which effect mouse killing have similar effects on intermale fighting Prior familiarity with the appropriate stimulus animal inhibits both intermale fighting [Galef 1970a] and mouse killing [Galef 1970a] while familiarity with the test environment faciliates both [Barnett 1969 Karli 1956] In addition food deprivation inceases the probability of mouse killing [Paul et al 1971] and may increase fighting between male rats [Davis 1933]

The similarity in conditions which initiate these two kinds of aggression suggest that a common mechanism is involved in both If so the two behaviors should also be correlated That is animals that are mouse killers should also be the most vigorous intermale fighters Experiment 1 therefore examined whether this correlation exists

## GENERAL METHOD

### Subjects

Male Long Evans rats weighing 200–300 gm were used as subjects They were housed and tested in individual wire mesh cages

### Stimulus Animals

Adult male Sprague Dawley rats matched for weight to that of the subject with which each was paired were used in the intermale fighting tests The juvenile rats used in the fighting tests in experiment 2 weighed 60–120 gm Adult Swiss mice were used in the mouse killing tests

### Aggression Tests

To test for mouse killing a mouse was placed in the subject s cage for 30 minutes or removed within 60 seconds of death The latency to kill was recorded

Tests with the strange male rat lasted 15 minutes Subjects were rated a) as sava e fighters if posttest examination showed that the albino bled from at least one wound b) as fighters if bites were sufficiently hard to evoke squealing from the victim or c) as nonfighters if these behaviors were not observed

## EXPERIMENT 1

### Method

After one week of adlib feeding each of the 75 subjects was maintained at 85% of its adlib feeding weight After four days at 85% of its adlib feeding weight After four days at 85% body weight the subjects were tested in counterbalanced order on two days once with mice and once with male rats

### Results

Twenty four of the 75 subjects (32%) killed mice and 17 of the 75 subjects (23%) attacked the strange albino rats Table I shows that more mouse killers fought other rats than did nonkillers ($\chi^2 = 8\ 95$ df = 1 $P < 0\ 005$) Further more for rats which killed mice fighters tended to attack mice more quickly than did nonfighters (median latencies of 60 vs 90 seconds Mann Whitney U = 41 df = 11/13 $P < 0\ 10$)

Prior exposure to the albino rat had no effect on subsequent mouse killing ($\chi^2 < 1$) and exposure to mice had no appreciable effect on fighting ($\chi^2 = 1\ 09$ df = 1 $P > 0\ 20$)

## EXPERIMENT 2

Practice in one kind of aggression may strengthen the tendency to another kind of aggression Previous aggressive experience can strengthen subsequent

**TABLE I** Number and Percentage of Killers and Nonkillers That Fought With an Unfamiliar Male Rat

| Response | Type of subject Killer | Nonkiller |
|---|---|---|
| Savage fight | 2/24 (8 3%) | 0/51 (0 0%) |
| Fight | 9/24 (37 5%) | 6/51 (11 7 ) |
| No fight | 13/24 (54 2%) | 45/51 (88 3%) |

aggression of the same type [Ginsburg et al 1942 Scott et al 1951] and it can raise the probability of attacking a stimulus animal not ordinarily attacked [Kahn 1951 Lagerspetz et al 1967] Extensive mouse killing experience may increase the percentage of subjects attacking male rats The subjects were tested with both adult and juvenile rats since mouse killing experience does transfer to killing *weanling rat pups [Paul et al 1973] A food satiated group was also included to* determine if hunger increases fighting Previous studies have obtained conflicting findings [Davis 1933 Lester et al 1968]

### Method

Fifty seven subjects were randomly assigned to three groups Then all subjects *except those in the Food Satiated group which remained on adlib food* were reduced to and maintained at 80% of their adlib weight

After four days at 80% weight the Mouse Exposure group was given 20 mouse killing tests two per day for ten days The two other groups were not tested for mouse killing All three groups were tested for intermale fighting on the two days following the Mouse Exposure group s last mouse killing test By a random method half of the subjects in each group were first tested with a juvenile rat and half were first tested with a mature rat

### Results

Although 88% (15/17) of the Mouse Exposure group eventually killed mice this group did not fight more frequently with either adult males ($\chi^2 < 1$) or with juvenile male rats ($\chi^2 < 1$) than did the group not exposed to mice How ever food-deprived rats (Mouse Exposure and No Mouse Exposure groups com bined) were more likely to fight with mature rats ($\chi^2 = 5\ 21$ df = 1 $P < 0\ 05$) and juvenile rats ($\chi$ = 3 69 df = 1 $P < 0\ 10$) than were rats in the Food Satiated group

## EXPERIMENT 3

All rats possess the neural mechanisms necessary for mouse killing [King et al 1968 Vogel et al 1971] The difference between those which attack and those which do not must be in how easily the attack can be evoked *This difference in* aggressiveness may be caused by the killer rats being generally more emotionally responsive If so it should be possible to predict which rats will kill mice on the basis of their emotional responsiveness

In order to attribute such a correlation to general emotional responsiveness the test of emotionality should be quite different from the aggression test Attack involves detection approach and initiation of a sustained pattern of responding to the stimulus animal To eliminate factors governing responsiveness to social stimuli emotionality was assessed by the amount of shock produced disruption

of an ongoing instrumental response (conditioned emotional response CER) CER measures the animal s emotional response to an aversive stimulus [Estes et al 1941]

To insure the reliability of the findings the experiment was replicated with some modifications in procedure

## Method

Ten operant chambers were equipped with a stainless steel grid floor a solenoid operated water dipper and a single bar A flashing light stimuls was produced by a 7.5 watt light behind a frosted glass and electric grid shock was produced by a variable transformer and a fixed series resistor The procedure was run in two replications

Replication 1 Eighteen subjects were given food adlib but were water-deprived for 2? hours prior to each experimental session Lever pressing was conditioned for water reinforcement on four sessions of 60 responses each For the remainder of the experiment lever pressing was reinforced on a 60 second variable interval (VI) schedule Daily session length was 90 minutes

Starting on the tenth day of VI training four presentations of a four minute flashing light were given per session After three days of habituation to the light shock was introduced (fear acquisition phase) To maximize individual differ ences in shock produced suppression shock randomly followed the flashing light (CS) on 50% of the trials On appropriate trials shock onset preceded termina tion of the CS by 0 5 seconds and terminated 0 5 seconds after the offset of the CS Shock intensity was 0 55 mA for the first four days of fear conditioning and 0 63 mA for the remaining five days Fear acquisition was followed by seven days of fear extinction during which the CS was presented but no shocks delivered The number of responses made each day during the four minute ]re CS and 4 minute CS periods were recorded

After the last extinction session all subjects were given free access to water and placed on a 23 hour food-deprivation schedule On the sixth and seventh days subjects were tested for mouse killing

Replication 2 Twenty subjects were subjected to the same procedure as in replication 1 except that the fear acquisition phase lasted 11 days and no extinc tion phase was run During fear acquisition the shock level on days 1–3 was 0 3 mA on days 4–5 it was 0 4 mA on days 6–7 it was 0 5 mA and on days 8–11 it was 0 65 mA

## Results

Replication 1 Eight of the 18 subjects killed mice Killers and nonkillers did not differ in their response rates on the last day of VI pretraining (34 vs 58

responses per four minutes Mann Whitney U = 29 P > 0 10) or during the CS and pre CS periods of the last day of CS habituation (62 4 vs 54 3 U = 37 P > 0 10 67 1 vs 66 3 U = 34 P > 0 10)

Figure 1 shows for killers and nonkillers the daily means of the median (for each subject) number of responses in the CS period of acquisition Killers were more suppressed during the CS than were nonkillers on the last five days of fear acquisition (3 5 vs 17 9 U = 11 5 P < 0 02) The mean of the median number of responses for killers and nonkillers during the pre CS interval is shown in Figure 2 Killers were much more suppressed by fear during the pre-CS interval than were nonkillers during the last five days of fear acquisition (19 7 vs 51 7 U = 9 P < 0 01)

Kamin suppression ratios (B/(B + A) where B is the press rate during the CS and A is the press rate during the four minute period preceding the CS) were

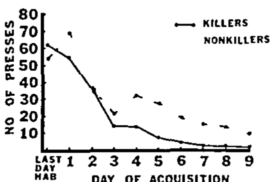



Fig 1 Mean of the median number of presses per day during the CS period for killers and nonkillers

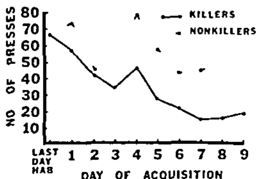



Fig 2 Mean of the median number of presses per day during the pre-CS period for killers and nonkillers

calculated for each session The median suppression ratio of killers (0 08) on the last five days of acquisition was not reliably different from that (0 21) of non killers (U = 24 P > 0 05) However it was reliably lower (0 15 vs 0 34 U = 13 P < 0 02) on the last two days of fear extinction

Replication 2 Twelve of the 20 subjects killed mice Killers and nonkillers did not differ either in their press rate during the last day of VI pretraining (33 vs 42 responses per four minutes U = 39 P > 0 10) or during the CS and pre CS periods of the last day of CS habituation (187 vs 253 responses per day U = 36 P > 0 10 186 vs 278 responses per day U = 36 P > 0 10)

On the last five days of fear acquisition the response rate of killers was more suppressed than was that of nonkillers during the pre-CS period (mean of the median number of presses per day 125 vs 309 U = 17 P < 0 02) but not during the CS period (59 vs 75 U = 51 5 P > 0 10)

## DISCUSSION

The results suggest that two forms of aggression previously considered to be quite distinct probably share a common arousal mechanism Subjects that fought other rats were also the animals that killed mice In addition the mouse killing latencies of rats which attacked strange rats tended to be shorter than those of rats that did not Nevertheless experience in mouse killing did not strengthen the tendency to attack novel rats (experiments 1 and 2)

The correlation between mouse killing and CER suggests that aggressive rats are more emotionally responsive and more fearful than are less aggressive rats Since the subjects were not tested for mouse killing until after the CER tests factors such as killing experience and food deprivation which affect the probability of killing could not have affected CER performance While mouse killers tended to show greater response suppression than did nonkillers during the CS periods the greatest difference between these groups was in the amount of suppression during the pre-CS periods of shock acquisition Two previous studies [Tapp 1964 Weiss et al 1969] also found that the largest differences in suppression occurred during the pre-CS intervals Suppression during the pre-CS interval in dicates that killers are more emotionally responsive to general situational cues rather than being more easily or strongly conditionable as would be suggested by differences in responding during the CS periods or by differences in Kamin ratios This conclusion is supported by Vergnes Boehrer and Karli s report [1974] that mouse killing rats were more emotional in an open field situation than were other rats

Finally because the response rates of killers and nonkillers were virtually identical prior to fear conditioning the differences in suppression cannot be attributed to a difference in general activity level Indeed these data show that mouse killers and nonkillers are not differentially responsive to all situations

Differences appeared only when the animals were emotionally aroused either when confronted with a strange rat or in a fear producing situation

Environmental conditions which raise responsiveness presumably via emotional arousal including novelty [Galef 1970a] pain [Bowers 1973 Ulrich et al 1962] and hunger (experiment 2 and Paul et al [1971]) produce increases in both fighting and mouse killing The data from correlations between mouse killing and fighting and from environmental manipulations support the idea of a common arousal mechanism being involved in several kinds of aggressiveness and fearfulness Such a commonality would underlie the initiation of the response in these situations Therefore strengthening one aggressive response might not have any effect on other aggressive responses This was demonstrated in experiment 2 by the fact that extensive practice in mouse killing did not facilitate intermale fighting It also explains why mouse killing does not correlate with traditional measures of dominance between rats [Baenninger et al 1970 Barr et al 1975] Aggressive responses are under multiple control These experiments suggest the need for research which separates the stimulus and response factors

These data point to a new criterion for distinguishing between classes of aggression Previous ways of categorizing leave open some possible relationships such as the demonstrated correlation across animals Although these data and other considerations (see for example Johnson [1972] p 20) blur the distinction between categories of aggression it may be useful particularly from a heuristic point of view to keep the distinctions but sharpen the criteria A good criterion for distinguishing between classes of aggression is nontransfer of the effect of practice from one form of aggression to another

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AGGRESSIVE BEHAVIOR
Volume 5 pages 51–58

# Pre-Breeding Aggression in Male and Female Three-Spined Sticklebacks (Gasterosteus aculeatus)

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The reactions of 34 female and 32 male three-spined sticklebacks to a conspecific were observed in the month before the breeding season Factor analysis indicated that the organisation of the response in the two sexes was very similar in both cases axes labelled "aggression" "threat" "curiosity" and "sex" emerged with male fish having significantly higher scores on the first factor and females on the second. Any theory of the causes of aggression in sticklebacks should accommodate these facts

Key words aggression female male season sexual behaviour stickleback

## INTRODUCTION

The traditional picture of aggression in the three spined stickleback is of a behaviour pattern shown by breeding adult males only in defense of a territory and in response to a highly specific stimulus – the red breast of an intruding male [Tinbergen 1951] However immature sticklebacks of both sexes [Sevenster and Goyens 1975] nonbreeding adults [Huntingford unpublished data] and sexually mature females [Morris 1958 Wootten 1976] also attack conspecifics and not usually in a territorial context Moreover this response can be elicited by stimuli other than

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breeding males or models of them [Muckensturm 1967 Sevenster and Goyens 1975] In two other species of stickleback (Pygosteus pungitius and Culea inconstans females as well as males have been described as territorial in some laboratory studies at least [Hall 1956 Morris 1958] Thus as Wootton [1976] points out a complete understanding of the incidence of aggression in sticklebacks cannot be achieved by studying the behaviour of sexually mature males alone

This paper describes the behaviour of adult male and female three spined stickle backs observed during a one month period immediately before the onset of the breeding season Although the primary aim of these experiments was an investiga tion of possible hormonal bases of aggression not necessarily in a territorial context they might also be expected to throw light on more general aspects of the organi sation of this behaviour in both sexes

## MATERIALS AND METHODS

The observations were carried out on sticklebacks from Inverleith pond Edin burgh in late May and early June of 1977 a year in which the very cold winter and spring delayed the onset of the breeding season All fish were sufficiently large to be capable of breeding (mean weight for males 0 89 gm for females 0 92 gm) but none had reached full reproductive condition

The fish were kept at a temperature of approximately 20 C on a lighting sche dule of 16 hours light–8 hours dark and were fed daily on Tubifex worms and Daphn. They were housed singly in tanks of 60 X 30 X 30 cm for a period of five days be fore testing which involved placing an adult male with no trace of breeding colours (the stimulus fish ) in the centre of the tank confined in the bulb of a glass flask Five minutes observation began when the fish being watched (the test fish ) was first in a position from which it could potentially see the stimulus fish During each trial the following behaviour patterns on the part of the test fish were recorded

Facing test fish still with the whole body pointed towards the stimulus fish This category is subdivided on the basis of whether the test fish is more or less than 10 cm from the stimulus fish

Spine raising complete raising of the dorsal and/or ventral spines

Approach slow movement from a facing position towards the stimulus fish through at least 2 cm starting from a distance of at least 5 cm and not ending in contact with the glass

Lunge rapid dart towards the stimulus fish from a facing position at less than 5 cm and with the mouth closed ending against the glass

Bite rapid jab at the glass flask with the mouth open and then closed

Head-down vertical posture with the side or ventral surface towards the stimulus fish with one or both of the ventral spines raised accompanied by rapid jabbing movements at the substrate

Zig zags one complete towards and away movement with spines raised typical of the male stickleback s courtship dance

After testing the fish were killed for histological investigations and their sex determined altogether 34 females and 32 males were tested

Although these observations were made in an experimental situation traditionally used for studying territorial behaviour (ie an intruder is placed in a tank containing a resident fish) and although at this stage of the year the male fish may have been beginning to establish territories [Van den Assem 1967] this study did not address itself to the question of whether the behaviour observed was site dependent and therefore possibly territorial The aim was simply to provide a quantitative account of the behaviour patterns shown towards a conspecific by prebreeding fish and to study the temporal relationships of these patterns Any similarity or lack of it with the obviously territorial response of breeding male sticklebacks is a matter for discussion

## RESULTS

Table I shows the mean values for males and females of various measures of the response to the intruder and the results of t tests carried out on the individual scores Males show significantly higher levels than females for lunges and bites the reverse being the case for head-down threat postures

In order to investigate more fully the integration of these various acts in the two sexes the scores for all the males and those for all the females were analyzed by the method of principal components followed by Varimax rotation This method is widely used in psychology and in many branches of biology and its application

TABLE I Mean Values of Eleven Measures of the Response of Male and Female Fish to an Intruder

| | Males | Females | t test result |
|---|---|---|---|
| Facing from < 10 cm–No | 9 94 | 9 41 | no sig diff |
| Facing from < 10 cm duration | 48 72 | 43 68 | |
| Facing from > 10 cm–No | 2 03 | 2 23 | |
| Facing from > 10 cm–duration | 1 09 | 4 35 | |
| Spine raising–No | 15 25 | 15 91 | |
| Spine raising–duration | 17 46 | 20 21 | |
| Approaches–No | 4 00 | 4 50 | |
| Lunges–No | 176 78 | 130 18 | $P < 0\ 05$ |
| Bites–No | 98 62 | 58 09 | $P < 0\ 05$ |
| Head-down postures–No | 1 46 | 3 47 | $P < 0\ 05$ |
| Zig zags–No | 3 87 | 2 15 | no sig diff |

to the territorial behaviour of breeding male sticklebacks is described by Hunting ford [1976] Briefly the analysis investigates the matrix of covariances or correla tions between a number of variables (in this case the behaviour patterns shown by the sticklebacks) and produces a new set of axes or factors in terms of which the information contained in the original block of data can be restated Each factor is characterized by a set of loadings for all of the original variables with those vari ables which are correlated loading on the same factor and those which are unrelat ed loading on different ones Thus in the present case groups of causally related behaviour patterns can be identified in an objective way on the basis of the fact that they all have high loadings on a given factor In addition a compound measure (referred to here as the factor score ) reflecting the overall performance of an individual subject with respect to a particular group of behaviour patterns can be calculated from the loadings of each behaviour pattern on the relevant factor and the fish s original scores for these variables Thus this method of analysis provides a picture of the overall response to the stimulus fish in sticklebacks of both sexes and a method of quantifying the behavioural differences between individual fish

Figure 1 shows the first four factors to emerge from the two analyses These not only account for an identical proportion (81%) of the total variance but also

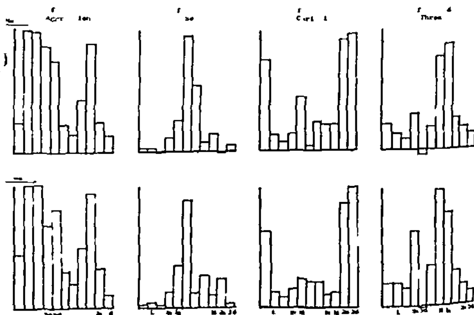


Fig. 1 Structure of the first four factors which emerged from analyses of data from prebreeding males and females Vertical axis size of factor loading for each variable on an arbitrary scale Horizontal axis behaviour patterns used in analyses Key to variables A–approach L–lunge B–bites Sn and Sd–number and duration of spine raising Z–zi zag H–head-down 1n and 1d–number and duration of facing from less than 10 cm 2n and 2d–number and duration of facing from more than 10 cm

have remarkably similar patterns of loadings in the two sexes Factor a which has high loadings for lunges bites and facing from close up provides an index of overt a gression as distinct from factor d whose high loadings for head down threat and facing indicate a dimension of threat independent of actual attack Factor c with high loadings for lunges bites spine raising and facing from close up provides an index of overt aggression as distinct from factor d whose high loadings for head down threat and facing indicate a dimension of threat independent of actual attack Factor c with high loadings for approach and facing from a distance represents what might be called curiosity on the part of the sticklebacks while factor b reflects the sexual aspect of the response having high loading for zig zags Thus the analysis has identified four major dimensions in the response of both prebreeding males and prebreeding females to a conspecific introduced into a familiar tank

Table II shows the mean scores of the two sexes on these four factors and the results of t tests on the scores of the individual fish There are no significant differences between the scores of males and females on factors b or c but as might be expected from the raw data males have significantly higher scores on the aggression axis (a) and females on the threat axis (d)

## DISCUSSION

### a Factor Structure

Multivariate analysis of the data obtained from these prebreeding sticklebacks has identified dimensions in the behaviour of both sexes which have been referred to as overt aggression threat curiosity and sexual behaviour This marked similarity in the structure of the four major factors in male and female prebreeding fish indicates that the organisation of the response to the stimulus fi h in the two sexes is alike Where the first three factors are concerned this was perhaps to be expected since as already mentioned female sticklebacks are known to approach investigate threaten and attack conspecifics [Wootton 1976] to quote Morris [1958] 'The aggressive actions and postures occur in both sexes (of Pygosteus) in exactly the same way A partial explanation in physiological terms for this similarity of behavioural organisation may lie in the fact that the level of aggression

**TABLE II** Mean Scores of Males and Females on Factors a–d

| | Males | Females | t test result |
|---|---|---|---|
| Factor a ( aggression ) | 0 94 | 0 60 | P = 0 05 |
| Factor b ( sex ) | −0 17 | −1 60 | no sig diff |
| Factor c ( curiosity ) | 0 17 | 0 53 | no sig diff |
| Factor d ( threat ) | 0 23 | 0 51 | P < 0 05 |

shown by sticklebacks appears to be partly controlled by gonadotropic hormones [Baggerman 1956 Hoar 1962 Wootton 1970] Both males and females in these experiments had well developed but not fully developed gonads They there fore presumably had the high levels of circulating gonadotropins necessary for ag gressive behaviour to rise towards the high levels associated with breeding in the males However this observation pushes the question one stage back since it is now necessary to assume that the neural substrates on which the gonadotropins act to produce aggressive behaviour are similar in organisation in the two sexes this need not necessarily have been the case

On the other hand the fact that females showed the zig zagging movements usually thought of as typical of the courting male stickleback is more difficult to understand In both sexes bouts of zig zagging were relatively rare and of short duration compared with those shown by fully breeding males however the zig zagging movements that the females did perform were indistinguishable from those of the prebreeding male fish There is no possibility that the sexes were wrongly assigned as all the females had well developed ovaries and there was no indication from the state of their kidney tubules that these fish were producing any testosterone [Hoar 1962] a hormone which is known to be involved in the sexual behaviour of sticklebacks [Wai and Hoar 1963] Morris [1952] has described the occurrence of pseudo female behaviour in male sticklebacks although his interpretation has been questioned [Van den Assem 1967] He gives no examples of pseudo male behaviour of females of this species although he does point out that where one sex performs the patterns belonging to another sex it is more fre quently the female that performs the male pattern rather than vice versa Other wise the male behaviour shown by the females in this experiment was completely unexpected and its significance is unclear It is possible that as Tinbergen suggested iour scores used in particular in the ways of measuring the amount of facing from the two distances (see legends of Figs 1 and 2) In spite of these facts recogni

In order to allow some comparison of the behaviour of these prebreeding sticklebacks with that shown by breeding fish Figure 2 reproduces the results of a Principal Components Analysis with Varimax rotation on some data collected from breeding males with newly built nests [Huntingford 1976] There are obvio ly physiological differences between these two sets of fish as well as a difference in their immediate environment In addition the stimulus fish used was a male in full breeding colours and there were some minor differences in the actual behav iour scores used in particular in the ways of measuring the amount of facing from the two distances (see legends of Figs 1 and 2) In spite of these facts recog zable dimensions of aggression curiosity and sexual behaviour emerge in both cases Thus it would appear that the structure of the response to the stimulus fish in prebreeding sticklebacks of both sexes is broadly similar to that of the more co monly studied fully reproductive males towards a territorial intruder However th are two obvious differences *in the first place no axis of nest activity emerged fro* the present data which is hardly surprising since none of the subjects built nests Secondly there is no equivalent of the prebreeding factor b in the earlier studies of

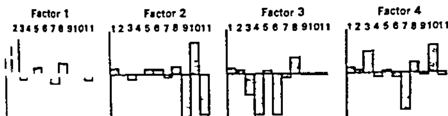



Fig 2 Structure of first four factors which emerged from analysis of data from fully breeding males [Huntingford 1976] Vertical axis size of factor loading for each variable on an arbitrary scale Horizontal axis behaviour patterns used in analysis. Key to variables 1 number of lunges 2 number of bites 3 number of zig zags 4 number of bouts of nest activity 5 number of spine raising incidents 6 total duration of nest activity 7 total duration of spine raisin 8 9 mean bout length of facing from less than 10 and more than 20 cm 10 11 proportion of time facing from less than 10 and more than 20 cm Factor 1 = "aggression " Factor 2 = "curiosity" Factor 3 = "nest activity " Factor 4 = "sexual behaviour "

fully breeding males This is because head-down threats were extremely rare in those experiments a fact which is less easy to explain Tinbergen [1952] suggested that head-down threats in sticklebacks is derived from a displacement activity resulting from a conflict between the tendency to attack and to flee thus accounting for their occurrence mainly at territorial boundaries Bearing this is mind there are at least two possible explanations for the absence of head-down threats in the 1976 tests The first is based on another (unintentional) difference in experimental technique between the two sets of tests It is generally accepted that a member of a territorial species placed in the territory of a conspecific invariably flees from the resident s attack In the 1976 experiments this always happened However in the present experiments the stimulus fish often counterattacked either because sticklebacks from Inverleith pond are particularly aggressive (Huntingford unpublished data) or because test fish without full breeding colours are less intimidating or both As head-down threat was often shown in response to this unusual situation it is possible that the motivational conditions which produce the display were provided in the present experiments but not in earlier studies Alternatively the difference in frequency of performance of head-down threat may represent a real difference in the response of prebreeding and fully breeding sticklebacks to the experimental situation For example in the absence of a well defined territorial system as in the prebreeding tests conflict between attacking and fleeing in reaction to a stimulus fish may occur more often These two possibilities are not mutually exclusive

## b. Scores of Individual Fish

Although the males have significantly higher scores on the aggression factor the female sticklebacks still showed well developed aggression in these tests The fact that females have higher threat scores may reflect their lower aggressiveness as well as a possible difference in fearfulness making the motivational balance bel be responsible for this posture more often achieved in this sex

## CONCLUSIONS

The results described above indicate that the organisation of the responses of male and female three spined sticklebacks to a strange consepecific in the period just before the breeding season are broadly similar as are the responses of pre breeding and fully breeding males although the actual levels of the behaviour patte may differ Any theory of the control of aggression in sticklebacks must take this into account

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AGGRESSIVE BEHAVIOR
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# Aggressiveness and Dominance in Captive Cock Red Grouse

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A method for measuring the aggressiveness of captive cock red grouse is described A cock s aggressiveness varied according to season type of cage and social environment A method for ranking the dominance order of cocks in a group is also described Dominance ranks remained stable for up to two years Correlations between the aggressiveness of isolated cocks and their dominance ranks when in a group were positive but weak Aggressiveness and dominance should be clearly distinguished Both aggressiveness and dominance were related to the size of cock s combs and implants of testosterone increased all three In situations where a cock s aggressiveness changed comb size changed in the same direction The aggressive behaviour of captive cocks shows several major parallels with that of wild cocks.

*Key words* aggression dominance comb size red grouse courtship

## INTRODUCTION

In wild red grouse (Lagopus lagopus scoticus) territory size is correlated with aggressive behaviour and changes in aggressive behaviour are followed by inverse

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changes in population density [Watson and Moss 1972] The aim of the present study was to measure aggressiveness and dominance in captive cock grouse to help improve our understanding of population change in the wild

Aggression is a term which has been used in so many ways by different workers [Brain 1977] that we have avoided it In this paper we use dominance to mean that social relationship which indicates the usual direction of aggressive acts between animals The frequency or intensity of such acts which we call aggressiveness is not necessarily related to their direction We therefore measured dominance and aggressiveness separately

## HUSBANDRY

Captive birds were hatched in captivity from eggs collected in the wild and from eggs laid in captivity Moss [1969] describes incubation rearing and hus bandry

Chicks were reared in brooder houses measuring 1 2 m X 1 2 m attached to 3 m X 3 m runs all groups were of 20–25 until 12 weeks of age when they were moved to cages 2 5 m X 1 2 m X 0 9 m in size with 8 birds to a cage In October or November we measured the aggressiveness of each cock in a separate isola tion cage (0.85 m X 0 90 m) where it could hear but not see other cocks After wards dominance was tested in larger cages (1 2 m X 2 4 m) and other tests were done subsequently in other large cages When not being tested cocks were in the isolation cages or in the larger cages with hens

## AGGRESSIVENESS

Hinde [1970] defined aggression as behaviour in which an animal attacks or threatens a conspecific in order to displace it and Huntingford [1976] noted that inter and intraspecific aggression are often closely linked We developed an aggressiveness score based on calls threats and attacks towards a human observer as this was the easiest way to elicit aggressive behaviour from captive cocks To justify the relevance of this to intraspecific encounters we checked (below) that a cock s tendencies to call at threaten or attack a human observer and another cock grouse were correlated

In this paper we describe several methods for measuring aggressiveness includ ing nominal classification scoring and ranking Nominal classification of calls and acts (Tables I II Appendix) was a necessary preliminary to scoring How ever after the aggressiveness score had been justified we used it for all measure

TABLE I. Number of Cock Red Grouse Which Threatened or Attacked an Observer Standing in Front of Each Cage in Relation to the Calls That Each Cock Gave During One 10-Second Observation in February

| Kind of call | No threat or attack | Threat | Attack | Statistical comparison between lines | Significance level |
|---|---|---|---|---|---|
| No a b or c | 58 | 0 | 0 | 1 vs 2[a] | 0 05 |
| a only | 23 | 2 | 1 | 2 vs 3 and 4 combined[a] | 0 005 |
| a & b | 4 | 5 | 3 | | |
| a, b & c b & c or a & c | 3 | 1 | 5 | 3 vs 4[b] | 0 136 |

[a] 2 X 2 contingency table, combining threat and attack

[b] Fisher exact probability

This (February) result was typical of hundreds of sets of observations when scoring cocks for aggressiveness except that a large sample was used here for statistical reasons

TABLE II. Response of 51 Red Grouse Cocks to a Human and a Stuffed Grouse (April) During One 10-Second Observation

| Response to stuffed grouse | Response to human | | | | |
|---|---|---|---|---|---|
| | escape | none | call a | calls b or c with or without a | attack/threat |
| escape | 1 | 4 | 2 | 1 | 1 |
| none | 0 | 14 | 7 | 1 | 2 |
| call a | 0 | 0 | 4 | 0 | 1 |
| call b or c | 0 | 0 | 1 | 1 | 6 |
| attack/threat | 0 | 0 | 0 | 0 | 5 |

Responses are ordered from escape (taking flight or running up and down the back of the cage) to most aggressive (attack/threat) The contingency coefficient C (with five degrees of freedom) was calculated by classifying responses to stuffed grouse as 1) the same as the response to a human 2) one category more aggressive or less aggressive 3) two categories different 4) three categories different 5) four categories different ($C = 0.63$ $P < 0.001$)

ments where cocks were held long enough (a week or more) to allow the repe observations necessary for it When measurements had to be made over too sh a period to allow this aggressiveness was ranked

### Calls Postures and Acts of Threat and Attack

Watson and Jenkins [1964] described several postures and associated cal that wild cocks use whilst excluding other cocks from their territories Caged cocks also show these towards other cocks and towards human observers We noted the occurrence of three of these calls the appropriate phonetics by Wat and Jenkins [1964] being

krrow for our call a which they associated with threat
kohway for our b which they associated with attack intention and
kohwah for our c which they associated with attack

We avoided making assumptions about the meaning of different postures by re cording attack only when a cock tried to peck or buffet the observer throug the wires and threat when it called and advanced to the front of the cage bu did not touch the wires Birds calling but not advancing were recorded as mere giving calls a b or c

Some cocks called threatened and attacked more than others which sugge that these cocks were being more aggressive To check this we noted whether c a b and c accompanied threat and attack in captive cocks as in wild cocks [Watson and Jenkins 1964] An observer to whom the birds were accustomed spent ten-second periods standing in front of each cock in its isolation cage nc ing separately each type of call made by the bird and also whether or not it attacked or threatened him

Cocks giving call a only were more likely to threaten or attack the observer than those not calling at all but were less likely to do so than those giving som b and/or c (Table 1) Although cocks that gave some c calls attacked the ob server more often than those that gave a and b but no c this difference was no significant We concluded that calls a b and c accompanied aggressive respons to an observer and b and c accompanied a more aggressive response than a on own

### Scoring of Aggressiveness

To score the aggressiveness of each cock an observer walked along a row of cages paused for ten seconds in front of each and recorded whether that cock gave calls a b or c and whether it threatened or attacked him He did this twi a day for seven to ten days He gave 2 points if a cock called and attacked (no cock attacked without calling) 1½ if it advanced towards him and called with

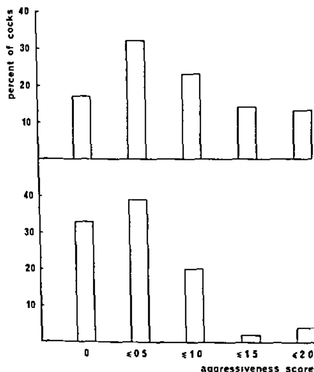



Fig 1 Distribution of aggressiveness s ores in March (top 69 cocks) and November (bottom 51 cocks)

out attacking 1 if it called when he stood in front of it and ½ if it called only when he was approaching or leaving To calculate an individual cock s aggressiveness score we divided the total number of points for that cock by the number of ten-second observations for it (see Appendix for a detailed justification)

Although the aggressiveness score was a parametric measure it was not normally distributed (Fig 1) and so it may not be strictly valid to use parametric statistics However the parametric methods that we used are well known to be robust and for every parametric correlation coefficient given in this paper we also did a nonparametric test these invariably gave similar results We present parametric correlation coefficients where possible as these indicate what proportion of the observed variation is accounted for by the relationship Nonparametric correlation coefficients are given where one or both of the two variates were ranked

**The Validity of the Aggressiveness Score**

We compared each cock s response to an observer standing in front of its cag with its response to a stuffed stationary standing cock grouse with erect comb which it had never seen before A hidden observer presented the stuffed cock fo ten seconds on the end of a long pole Fewer cocks showed threat and attack to the stuffed cock than to a human and more showed escape responses but the responses to both stimuli were highly correlated (Table II)

Was the aggressiveness score elicited by a human comparable with that elicit by a live cock grouse? After putting a live grouse crouching in a submissive pos ture in a movable cage in front of a cock s cage the observer recorded that coc responses for four minutes from a hide He next moved the stimulus grouse in front of the next cock s cage and so on for each of the 20 cocks As cocks responded much less vigorously to the stimulus cock than to a human we had t record their response for four minutes instead of the ten seconds as above The aggressiveness score elicited by a human observer was related to that elicited by live grouse outside the cage ($r = 0\ 79$ $P < 0\ 001$)

Could a cock s aggressiveness score be used to predict his response to a stran intruder cock presented inside his cage? We put the intruder inside each cock s cage only once for one minute to avoid any habituation by the home cock Using the same intruder throughout we compared each home cock s response with his aggressiveness score As the intruder sometimes crouched and sometime stood he was not a standard stimulus We overcame this by introducing him in a sequence random with respect to the home birds aggressiveness scores Althoug this could not prevent the possibility of extra variation in the home cocks respo (ie extra because of the nonstandard stimulus) it did prevent bias in the results

The brief aggressive response of each home cock to the intruder was ranked 1 – home cock attacked intruder 2 – called a b or c but did not attack and 3 – did not call a b or c or attack These isolation cages were so small that the intruder was inevitably very close to the home cock and any movement by the home cock towards the intruder almost always culminated in the intruder being pecked

Those cocks with the highest aggressiveness scores in the isolation cages (ie towards the observer outside the cages) were the ones most likely to call at and attack a strange cock put into their cage (Fig 2)

These results confirmed that a cock s aggressiveness score towards an observe was correlated with his tendency to attack a conspecific

**The Consistency of the Aggressiveness Score**

Although the mean aggressiveness score varied with season (Fig 3) one may still ask Is an individual cock s score similar in the same seasons in successive years? Also does the relative aggressiveness of a number of individual cocks re main constant throughout the year?

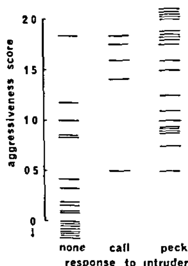
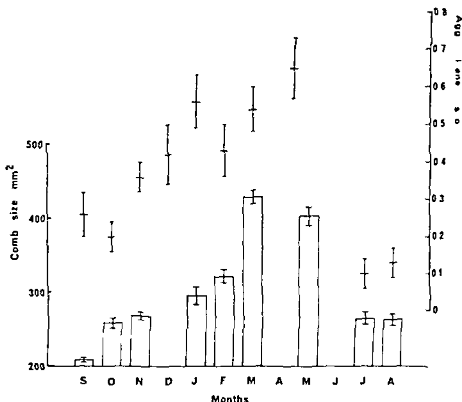



Fig 2 The aggressiveness scores of cock red grouse in isolation cages compared with their responses to an intruder cock (April)

Eight cocks kept permanently in isolation cages had their aggressiveness scores measured 10 times in 1½ years As the mean aggressiveness score varied with season we used correlations and not the statistic repeatability (Becker 1967] All 45 possible correlation coefficients (r) between scores on different dates were positive with a median of 0 66 and a range of 0 21–0 99 A different result occurred with cocks which had not been permanently in isolation cages In the interval between an aggressiveness test in autumn and a repeat in the following spring we had put these cocks into groups so as to rank their dominance (see below) in winter When they went back to the isolation cages in spring their scores did not correlate with those of the previous autumn but by the next autumn they did (Table III) Thus experience prior to isolation may have affected the aggressiveness score but the score was repeatable when prior experience was held constant

## Do Cocks Aggressiveness Scores Change When Their Environment Changes?

To study this we removed cocks from their isolation cages and put them into cages with three hens already present Although these were larger (1 5 X 2 1 m) than the isolation cages the floor area per bird was the same We made no attempt to determine the relative importance of change in cage size as against presence of hens




Fi 3 Annual variation in comb size (bottom) and aggressiveness scores (top) of captive red grouse As comb size increases with age the data on combs here are for birds in their first 15 months of life only The data are from several different groups of birds measured between 1969 and 1976 Means ± 1 standard error

**TABLE III Correlation Coefficients (r) Between Successive Aggressiveness Scores for Cock Red Grouse Which Were Moved Frequently During the Winter**

| Origin of eggs[a] | Dates of measurements | N | r | Significance level |
|---|---|---|---|---|
| 1973 (W) | Oct 73 Nov 74 | 12 | 0 78 | 0 01 |
| 1974 (W) | Oct 74 Mar 75 | 34 | 0 04 | NS |
| 1974 (W) | Oct 74 Nov 75 | 11 | 0 63 | 0 05 |

[a] (W) here and elsewhere indicates birds hatched from eggs taken from the wild

Each cock was left in his new cage for a few days and then his aggressiveness score was measured as above The scores did not correlate strongly between one test situation and another but when the birds went back to the isolation cages their aggressiveness scores returned to what they had been previously (Table IV) Hence altering the environment changed aggressiveness scores but these changes were reversible

Was the changed aggressiveness score of a cock in the large cage with hens present associated with a changed aggressive response to an intruder cock? As birds in these larger cages had a bigger area of floor and so more freedom of movement we could define more ranks for each cock s aggressive response than in the small isolation cages 1 – home cock chased and pecked intruder 2 – chased but did not peck 3 – called a b or c and stepped towards intruder but did not chase him 4 – called a b or c and 5 – did not call a b or c or move towards intruder Cocks with high aggressiveness scores were more likely to chase and peck a strange cock (Fig 4)

**TABLE IV** Correlations (r) Between Successive Sets of Aggressiveness Scores When Cock Red Grouse Were Moved From One Test Situation to Another and Then Back Again

| Dates when scored | Situation | | Correlations |
|---|---|---|---|
| | Experiment 1 (12 birds) | | |
| Nov 9–25 | hens present | $A^1$ | $A^1B$ – 0 127 |
| Nov 27–Dec 7 | cock isolated | B | $BA^2$ + 0 242 |
| Dec 12–19 | hens present | $A^2$ | $A^1A$ + 0 769** |
| | Experiment 2 (11 birds) | | |
| Nov 10–19 | cock isolated | $B^1$ | $B^1A$ + 0 329 |
| Nov 29–Dec 11 | hens present | A | $AB^2$ – 0 231 |
| Dec 26–Jan 12 | cock isolated | $B^2$ | $B^1B$ + 0 667* |

*Two-tailed $P < 0\ 05$ $P < 0\ 01$

Each of eleven cocks in isolation was successively scored for aggressiveness towards an observer presented with a strange cock inside the cage and ranked for his aggressive response to this intruder Each was then moved into a large cage with three hens again scored for aggressiveness and finally presented with a second strange cock and ranked for his aggressive response towards him The change in aggressiveness score towards an observer was correlated with the change in ranked aggressive response towards the intruding cocks ($r_s = 0.59$ $P < 0.05$)

## DOMINANCE

Two methods for assessing dominance ranks are 1) pairing one individual against another in a neutral place and 2) observing agonistic interactions amongst members of a group Both give similar results in red grouse [Kolb 1971] We used group tests because they gave more data more quickly and also because many aggressive interactions amongst wild grouse in winter occur while the birds are in groups [Watson and Jenkins 1964]

aggressiveness score
2·0
1·5
1·0
0·5
0
none call approach chase peck
response to intruder

Fig 4 The aggressiveness scores of cock red grouse in large cages with hens present compared with their responses to an intruder cock (Dec–Jan)

### Description of Dominance Behaviour in Group Tests

When captive cocks were put together in a cage they threatened each other spontaneously and did so more frequently while competing at a food tray They showed the entire range of threat and attack postures noted in wild cocks by Watson and Jenkins [1964] Most encounters were settled quickly by threaten ing or attacking Occasionally birds confronted each other in a horizontal fac ing" posture before one gave way but very rarely fought

### Measuring Dominance in Groups

Cocks that had been in isolation were put simultaneously into a cage in groups usually of eight We identified each bird by a coloured leg ring and observed from a hide Food was withdrawn for several hours during the day and then supplied in one dish immediately before our observations in the evening When all eight birds in a group were together we could clearly distinguish the most dominant ones but birds low in the order seldom interacted and so provided very few data [Kolb 1971] Therefore when a cock had been clearly the most dominant for two days we removed it whereupon another usually became dominant By repeating this procedure we could rank individuals in the order in which we had removed them We also recorded each individual interaction so as to calculate a dominance index [Butterfield and Crook 1968] for each cock These domi nance indices agreed well with the order in which we had removed the cocks We used them to decide the dominance of a few birds which had failed to show clear despot/subordinate relationships

When we had to rank more than nine birds at a time we separated them into groups of eight or less and ranked each group separately Selected individuals from each group were then tested against individuals from other groups at least two weeks afterwards This enabled us to rank each bird in a large batch against all others in it

### Consistency of Dominance Rankings

Dominance rankings were repeated at times varying from two months to two years The statistic repeatability [Becker 1967] was not appropriate as the data were nonparametric Repeated rankings were positively correlated in most cases significantly (Table V)

### Dominance Ranks in Relation to Aggressiveness Scores

Having measured the aggressiveness scores of individual cocks in isolation cages we put them in groups immediately afterwards and ranked their domi

**TABLE V Spearman Rank Correlation Coefficients ($r_s$) Between Successive Dominance Rankings for Cock Red Grouse**

| Date and origin of eggs[a] | Dates of testing | N | $r_s$ | Significance level |
|---|---|---|---|---|
| 1968 (W)[b] | Oct 68 Mar 69 | 6 | 0 98 | 0 01 |
| 1968 (T)[b] | Oct 68 Jan 69 | 8 | 0 79 | 0 05 |
| | Oct 68 Oct 69 | 8 | 0 60 | NS |
| 1968 (T)[b] | Nov 68 May 69 | 6 | 0 83 | 0 05 |
| 1969 (T)[b] | Oct 69 Dec 69 | 7 | 0 82 | 0 05 |
| 1969 1970 (W)[b] | Nov 70 Apr 71 | 7 | 0 64 | NS |
| | Apr 71 Oct 71 | 7 | 0 72 | 0 05 |
| | Nov 70 Oct 71 | 6 | 0 90 | 0 05 |
| 1970 (W)[c] | Feb 71 Sept 71 | 8 | 0 81 | 0 05 |
| 1971 (W)[c] | Oct 71 Nov 72 | 12 | 0 69 | 0 05 |
| | Oct 71 Nov 73 | 11 | 0 75 | 0 01 |
| 1972 (W)[c] | Nov 72 Oct 73 | 12 | 0 83 | 0 01 |
| 1972 (T)[c] | Mar 73 Dec 73 | 8 | 0 56 | NS |
| 1973 (W)[c] | Mar 74 Oct 74 | 22 | 0 53 | 0 01 |

[a] (W) birds hatched from eggs taken in from the wild (T) eggs from captive stock

[b] Birds retested in identical groups

[c] Retest of sample from a larger batch

**TABLE VI Rank Correlations ($r_s$) Between Aggressiveness Scores and Dominance**

| Birds hatched | N | $r_s$ |
|---|---|---|
| 1971 (W) | 11 | 0 79 * |
| 1972 (W) | 30 | 0 17 |
| 1973 (W) | 14 | 0 31 |
| 1974 (W) | 30 | 0 09 |
| 1974 (W) | 41 | 0 07 |
| 1974 (T) | 30 | 0 15 |
| 1975 (T) | 34 | 0 17 |
| 1975 (T) | 30 | 0 38* |
| 1975 (W) | 42 | 0 28 |
| | mean $r_s$ [Snedecor 1956] | 0 19 * |

*P < 0 05 P < 0 01

nance The two measures showed only a small positive overall correlation (Table VI) as they did also when the aggressiveness scores were determined in the large cages with hens present ($r_s$ = 0 28 n = 36 NS)

## COURTSHIP BEHAVIOUR

Wild cocks with large territories tend to have more aggressive encounters and to win them more often than cocks with smaller territories and also tend to have more hens [Watson and Miller 1971] We therefore anticipated that the aggressiveness and dominance rank of captive cocks should be related to their courtship behaviour

### Description of Test Situation

Courting cock red grouse show postures described by Watson and Jenkins [1964] Our captive cocks courted infrequently but did so more readily in the following situation

A cock which had been isolated for several weeks was put alone into a cage (1.2 X 2 4 m) After 24 hours a hen (the same in all tests) was introduced for an hour and the cock watched from a hide By the end of the hour the cock had generally finished his display if any and sat quietly or walked about To check that his responses were consistent we replaced the hen after 24 hours Preliminary tests indicated that cocks responded to the second presentation within a few minutes or else did not respond at all The procedure on the second presentation was therefore to note his reactions again for five minutes

### Ranking of Courtship Behaviour

Some cocks courted the hen in bouts lasting several minutes others in a series of bouts lasting a few seconds each and some only looked at the hen and partly erected their combs in brief flashes Some showed no sexual interest We ranked the cocks according to the total amount of time that they spent in courtship Many cocks sang between bouts of courtship and the number of songs was noted

In most cases a cock responded in the same way on both the occasions that the hen was put into its cage but a few cocks reacted more vigorously the second time This allowed us to rank some cocks which had earlier shown no sexual interest in the hen

### Ranking of Aggressiveness During Studies of Courtship

We also assessed aggressiveness during studies of the cocks courtship behaviour towards a hen This could not be done by measuring the parametric ag

**TABLE VII** Rank Correlations ($r_s$) Amongst Behaviour Measurements of Single Cocks in Tests Where a Hen Was Put into the Cage

| | Courtship | Song | Aggressiveness To observer | To grouse cock |
|---|---|---|---|---|
| Dominance | 0 93** | 0 83* | 0 82 | 0 63* |
| Courtship | | 0 89 * | 0 76 * | 0 90 * |
| No of songs | | | 0 81* | 0 81 |
| Aggressiveness to observer | | | | 0 66 |

*Each $r_s$ is a mean [Snedecor 1956] of 3 values (n = 8 8 6)*
P<0 05  P<0 01 (two-tailed)

gressiveness score as the test was done over too short a period and in any case the aggressive behaviour of some individual cocks changed rapidly after we put in the hen *We therefore had to record each cock s aggressiveness by ranking* The ranks were 1 – attacked observer during the test 2 – threatened observer 3 – called b or c 4 – called a only 5 – showed no aggressiveness to observer When we had finished studying each cock s courtship we introduced a quiet and un aggressive strange cock (the same in each case) into the cage and then ranked the home cock s response to the stranger 1 – chased and pecked stranger 2 – chased it 3 – walked towards stranger and called 4 – called b or c 5 – called a only 6 – showed no aggressiveness

### The Relationship Between Dominance Rank Aggressiveness and Courtship

Although the ranking of the cocks dominance did not correlate very well with the ranking of their aggressiveness scores in isolation (DOMINANCE and Table VI) the cocks aggressiveness and dominance were well correlated after the hen had been introduced for the measurements of courtship behaviour (Table VII) This was because the cocks aggressiveness often increased markedly after the hen was introduced

## COMB SIZE BEHAVIOUR AND THE EFFECT OF TESTOSTERONE *IMPLANTS*

### Measuring Comb Size

The red supraorbital combs of red grouse are a prominent feature in aggressive encounters and an important releaser for aggressive behaviour [Watson and Jen

**TABLE VIII Correlation Coefficients (r) Between Change in Aggressiveness Score and Change in Comb Size of Cocks Moved from One Cage Situation to Another**

| | Experiment 1 (12 cocks) | | |
|---|---|---|---|
| From | To | r | Signficance level |
| Hens present | isolation | 0 77 | 0 005 |
| Isolation | hens present | 0 81 | 0 005 |
| | Experiment 2 (11 cocks) | | |
| Isolation | hens present | 0 54 | 0 05 |
| Hens present | isolation | 0 39 | NS |

kins 1964] Birds behaving aggressively raise their combs but submissive cocks lower them out of sight under their feathers When erect each comb is roughly semicircular in shape and has a frilled outer edge After spreading the comb out the observer measured length horizontally at the base and height from the base to the highest point to the nearest ½ mm Length × height gave an index of comb size As comb size increased with age we have compared only cocks of the same year class

## Aggressiveness Score Comb Size and Testosterone Implants

Aggressiveness score and comb size were greatest in spring and least in summer (Fig 3) In eight out of the nine groups of birds tested aggressiveness score was significantly correlated with comb size measured at the same time (median $r = 0.41$ mean $n = 29$) Within each group individual cocks with high aggressiveness scores in the isolation cages usually had large combs and almost never small ones at the time when the scores were measured whereas cocks with low aggressiveness scores had a variety of comb sizes Among cocks tested with hens present the aggressiveness score correlated well with comb size ($r = 0.70$ $n = 36$ $P < 0.001$)

Short term increases or decreases in aggressiveness score were accompanied by parallel changes in comb size When cocks in isolation cages were moved to cages with three hens changes in their aggressiveness score were correlated with changes in their comb size (Table VIII) We also measured comb size in 14 of the cocks used for studying courtship In 10 of these comb size had increased within 48 hours of the hen being introduced

These results suggested that changes in androgen may have caused variations in comb size and associated behaviour We tested this by implanting cocks with

TABLE IX Effect of Testosterone Implants (15 mg) on Comb Size and Aggressiveness Score of Cock Red Grouse (Means + SE) Implanted July 30

| | | July 27 | July 30 | Aug 3 | Aug 5 | Aug 9 | Aug 11 | Sept 14 |
|---|---|---|---|---|---|---|---|---|
| Experiment | Comb size | 272 ± 9 | 278 ± 7 | 340 ± 9 | 372 ± 12 | 435 ± 8 | 440 ± 8 | 484 ± 9 |
| (n = 5) | Aggressiveness score | 0 4 ± 0 2 | 0 3 ± 0 1 | 0 5 ± 0 2 | 0 7 ± 0 3 | 0 6 ± 0 2 | 1 0 ± 0 3 | 1 4 ± 0 4 |
| Control | Comb size | 312 ± 18 | 312 ± 17 | 303 ± 20 | 318 ± 10 | 306 ± 12 | 300 ± 16 | 320 ± 20 |
| (n = 7) | Aggressiveness score | 0 1 ± 0 1 | 0 1 ± 0 1 | 0 2 ± 0 2 | 0 2 ± 0 2 | 0 1 ± 0 1 | 0 1 ± 0 1 | 0 3 ± 0 2 |

15 mg pellets of testosterone under the loose skin at the back of the neck whereupon comb sizes and aggressiveness scores increased (Table IX)

#### Dominance Rank and Comb Size

We measured the cocks' combs in isolation cages immediately before putting them into groups for ranking of their dominance We again measured the combs of every cock that we removed from the group during the work on the ranking Comb size was related to dominance (Table X) Also when we took the cocks out of the groups their comb size was usually more closely related to dominance than before they had gone into groups Cocks starting with small combs but dominant in the group had grown larger combs when we removed them from the group Subordinates starting with large combs had smaller combs when taken out

TABLE X Rank Correlations ($r_s$) Between Dominance Rank and Comb Size (Length X Height in mm) of Cock Red Grouse Measured Before Being Put in Groups for Ranking and After Being Removed From the Groups

| Test | No of birds | Before | After | Improvement |
|---|---|---|---|---|
| 1 | 8 | 0.60 | 0.77 | 0.77 |
| 2 | 8 | 0.42 | 0.61 | 0.61 |
| 3 | 8 | 0.43 | 0.61 | 0.37 |
| 4 | 7 | −0.20 | −0.16 | 0.54 |
| 5 | 7 | 0.43 | 0.58 | 0.42 |
| 6 | 7 | 0.68 | 0.71 | 0.63 |
| 7 | 6 | 0.77 | 0.75 | 0.09 |
| 8 | 7 | 0.14 | −0.27 | 0.60 |
| 9 | 8 | −0.50 | −0.51 | 0.56 |
| 10 | 8 | 0.78 | 0.51 | −0.53 |
| 11 | 8 | 0.40 | 0.71 | 0.64 |
| 12 | 7 | 0.82 | 0.86 | 0.55 |
| 13 | 8 | 0.50 | 0.67 | 0.65 |
| 14 | 7 | 0.47 | 0.43 | 0.17 |
| mean [Snedecor 1956] | | 0.44*** | 0.52** | 0.46*** |

The Improvement column shows the correlation ($r_s$) between the following two variables i) the difference between an individual's ranks for dominance and comb size before cocks were put into groups and ii) the change (ranked) in each individual's comb size while the cocks were in groups (see Fig 5)

$P < 0.001$

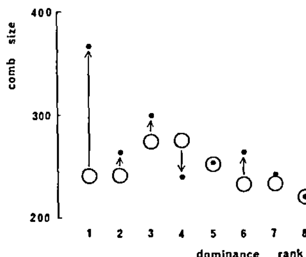



Fig 5 Comb size just before (open circles) and just after (black spots) dominance ranking This is test No 1 in Table X

shown by the Improvement column in Table X with an example in Fig 5)

**minance and Testosterone Implants**

The relation between comb size and dominance rank suggested that androgen y affect dominance To test this we implanted cocks with pellets of testosterone Having determined the dominance ranks of twelve cocks we selected six pairs ere the two members in each pair were close to one another in dominance k The two were housed in adjacent isolation cages separated by a partition ch we could remove when we wished to watch their reactions to one another We first determined the dominance relationships of the six pairs and then re ted this 17 days later to ensure that the relationships were reasonably st ble e of the six pairs showed the same dominance relationships towards one an er the second time as the first Only in pair three did the relationship re e remaining changeable throughout the experiment (Table XI)

We then implanted each of four cocks that had been consistently subordinate h a pellet containing 15 mg of testosterone and when it had dissolved we im nted a second The earlier dominance relationships subsequently reversed in four pairs The frequency with which reversals occurred was significantly ater after the subordinate cocks had been implanted than it had been before plantation (P = 0 024 Fisher exact probability test)

TABLE XI The Effect of Testosterone Implants (15 mg) on Dominance Relationships in Pairs of Cock Red Grouse

| Initial dominance order[a] | d 1 s | d 2 s | d 3 s | d 4 s | d 5 s | d 6 s |
|---|---|---|---|---|---|---|
| Date | | | | | | |
| 11/13/72 | > | > | > | > | > | > |
| 11/30/72 | > | > | < | > | > | > |
| 12/8/72 | | | | implanted | | implanted |
| 12/22/72 | > | > | < | > | > | < |
| 12/27/72 | implanted | | | | implanted | |
| 1/24/73 | > | > | > | < | < | < |
| 2/2/73 | | | | implanted again | | implanted again |
| 2/14/73 | > | > | > | < | < | < |
| 3/1/73 | implanted again | | | | implanted again | |
| 3/14/73 | < | > | < | < | DEAD | < |

[a] The pairs are listed in order of the mean dominance rank of the two members. d > s means d dominat s s. Increased aggressiveness was shown about five days after implanting in all four implanted birds Birds were "implanted again" when the first pellet had completely dissolved

We already knew that implants of testosterone increased aggressiveness (Table IX) and thus again occurred in the present experiment

Reversals in dominance occurred 2–11 weeks after implanting The pair reversing at 11 weeks had had the highest mean dominance rank whereas the two pairs reversing at 2 weeks had had the lowest ranks (Table XI) The time elapsing before reversal was related to the aggressiveness of the unimplanted initially dominant cock In short reversals occurred most quickly when the unimplanted bird was low in dominance ($r_s = 0.91$ NS) and in aggressiveness score ($r = 0.95$ $P < 0.05$)

## DISCUSSION

### Conclusions From This Study

A cock s dominance rank was more stable than his aggressiveness Dominance was determined from social relationships amongst birds Nonetheless it clearly had a physiological basis because both it and aggressiveness were correlated with comb size and increased after testosterone implants

During the work on dominance ranking dominant birds with initially small combs tended to grow bigger ones whereas the combs of subordinates with initially big combs decreased (Table X Fig 5) These dominant birds with initially small combs which had shown little aggressiveness before being put in the group probably had to show more aggressiveness once in the group to achieve the dominance ranks observed To judge by comb size an increase in androgen accompanied this greater aggressiveness Conversely big-combed though subordinate birds in the group showed less aggressiveness than in isolation perhaps because they were being dominated This may have caused their combs and presumably their androgen activity to decrease Thus although androgen activity apparently affected aggressiveness and dominance the relationship also seemed to go the other way

Correlations between aggressiveness and dominance were almost always positive but varied in strength according to the situation in which the aggressiveness was measured (Tables VI and VII) That correlations were positive suggests that some factors determining aggressiveness also determined dominance for instance androgen activity That correlations were weaker in some situations than in others indicates that aggressiveness and dominance were partly determined by separate factors Correlations were weakest in the two situations (cocks in isolation and cocks with three hens) where the cock had been in that situation for some days and had no other cocks with which to compete This suggests that aggressive traits which could be freely expressed (or suppressed) in secure situations were inhibited (or brought out) in competitive or stressful situations Therefore the amount of aggressiveness that a cock shows is not necessarily the same as what it is potentially capable of showing

Aggressiveness increased a few days after implants of testosterone but the dominance relationship between a pair of cocks reversed in all four pairs up to 11 weeks after the subordinate had been implanted even though the two cocks had been close in dominance rank beforehand This suggests that reversals in dominance rank may have been due to the greatly increased aggressiveness of the initially subordinate cocks but that other factors were also important and delayed the reversals

#### This Study and the Literature

Dominance in chickens is related to circulatory androgens [Collias 1943 Allee Collias and Lutherman 1939 van Krey and Siegel 1968] and also to moult [Collias 1943] body weight [Craig 1968 Siegel and Siegel 1963] and inheritance [Ortman and Craig 1968] Therefore differences in the dominance of chickens reflect variability in the physiology of different individuals as in grouse

Whether learning is important in establishing and maintaining dominance relationships in grouse is unknown If however the stability in dominance that we

found had been partly due to memory there must still have been initial differences amongst individuals which were then remembered As implants of testosterone increased a cock s dominance rank memory cannot be the only factor Furthermore there is evidence that differences in the ability of cock grouse to dominate other cocks are inherited [Moss et al 1974]

Syme [1974] pointed out that different dominance ranks as determined by the competitive order in which individuals feed drink or avoid electric shock do not always agree with each other Although we limited food so as to stimulate aggression our dominance rank is an aggressive rank in Syme s terminology as it was based solely on threat and attack and not on which individual had prior access to food Aggressive dominance ranks are generally stable and are useful as predictors of other behaviour [Baenninger 1966 Guhl 1958 Fisler 1977] and our results confirm both statements Of particular interest is the observation of Poole and Morgan [1976] that the individual house mice (Mus musculus) most likely to get territories could be predicted from their dominance ranks as determined before they took these territories Similarly wild pheasant (Phasianus colchicus) cocks which were dominant at winter feeding sites also began to establish their territories earlier in the spring than did sub-dominants [Collias and Taber 1951]

## Relevance of This Study to Research on Wild Birds

Although the behaviour of captive birds may include artefacts irrelevant in the wild our results show several parallels with behaviour in the wild 1) The aggressiveness accompanying call a is less than that accompanying b or c in the wild [Watson and Jenkins 1964] and in captivity (Table I) 2) In the wild [Watson and Miller 1971] and in captivity [Table VII Marquiss 1977 and other unpublished data] the aggressiveness of different cocks is correlated with their frequency of singing 3) In the wild an index of aggression was related to territory size [Watson 1964] and cocks from a population at low density and therefore with big territories had bigger combs than cocks from a population at high density with small territories [Moss 1967] In captivity comb size was related to aggressiveness and dominance 4) In the wild cocks with large territories had more hens than cocks with small territories [Watson and Miller 1971] In captivity dominant cocks spent more time courting a hen than did subordinates 5) After implants of testosterone captive cocks became firstly more aggressive and then more dominant and aggressive In the wild an implanted cock encroaches on his neighbours territories initially losing most of the disputes that he has thus started but subsequently winning many encounters [Watson 1970] We conclude that behaviour in captivity shows enough parallels with the wild to indicate that it is a good basis for further experimentation

Our finding that dominance and aggressiveness are sometimes only weakly related confirms that they are different kinds of behaviour [Kikkawa 1968] and may help explain some other observations on wild birds In black grouse (Tetrao tetrix) a peck-order in a feeding flock off the lek was not related to aggressiveness (ie tendency to initiate disputes) on the lek [Johnstone 1969] Watson and Miller [1971] who observed wild cock red grouse having encounters with neighbours at the boundaries of their territories noted that the result of such encounters was often that one bird gave way slightly However they found no significant correlation between the mean result and frequency of such encounters in one of the two years of their study Possibly their result of encounters is similar to our dominance and their frequency of encounters similar to our aggressiveness Clearly aggressiveness and dominance are not the same in red grouse and it may be useful to distinguish them in studies of other wild animals

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## APPENDIX

Here we justify the method used for scoring aggressiveness by showing that a cock s aggressiveness score is linearly related to his tendency to threaten or at ta k an observer

First we devised a measure of aggressiveness which incorporated the minimum number of assumptions This was Measure 1 the proportion of ten-second obser-

vations during which a bird attacked or threatened the observer We ignored calls Attack and threat were combined to avoid assumptions about the quantity of aggressiveness indicated by each act Although Measure 1 was therefore theoretically sound in practice it had the severe drawback that only about half of the birds threatened or attacked in spring and in autumn only about one tenth of them

Many cocks which did not threaten or attack the observer nonetheless gave the calls a b or c Measure 2 for aggressiveness was based entirely on calls a b and c The frequency with which a cock gave these calls was related to its aggressiveness in that cocks calling a b or c during a high proportion of the ten second observation periods were more likely to threaten or attack the observer than cocks giving thes calls during a low proportion of the observations (Tabl A I) Also calls b and c were associated with more aggressiveness than call a cocks which called b or c were more likely to threaten or attack than those calling a only (Table I) In a typical March sample the relation between threat and attack on one hand and calling on the other was empirically described by the equation

$$y = 0.34x_1 + 0.73x_2 - 0.05 \; (t_1 = 2.60 \;\; P < 0.025 \;\; t_2 = 7.99 \;\; P < 0.001 \;\; n = 69 \;\; R = 0.72)$$

where y is Measure 1 $x_1$ the proportion of observation periods during which a cock gave call a only and x the proportion during which it gave calls b or c in addition to or instead of a The left-hand side of this equation was a measure of aggressiveness and so therefore was the right-hand side Dividing the right-hand side by 0 34 and adding 0 15 gave an expression

$$x_1 + 2.1x_2$$

which was linearly related to Measure 1 even though it was based entirely on calls In Measure 2 for aggressiveness we allotted one point to a bird which gave call a only during a ten-second observation period and two points to a bird which gave b and or c (with or without a) The aggressiveness score (Measure 2) was the number of points divided by the number of ten-second periods

Measure 2 was adequate but had two drawbacks Sometimes a cock called when the observer stood at the next cage but not in front of that cock s own cage a moment later Table A II shows that a cock giving such "adjacent calls was less likely to attack or threaten the observer than a cock which called when the observer stood directly in front of its own cage (ie frontal calls) A second drawback was that although direct observations of threat and attack were the most direct measure of aggressiveness Measure 2 made no use of them

Measure 3 was therefore devised and it is the one used in this paper and described in the text Results from it were highly correlated with those from Measure 2 (r = 0 92 69 cocks 15 observation periods in March) Measurements by two observers who both used Measure 3 were also highly correlated (r = 0 89 48 birds 15 observation periods in January)

It would not have been a sufficient justification for Measure 3 to show merely that it gave results correlating with results from Measure 1 (r = 0 87 69 cocks in March) as both methods had observations of threat and attack in common and thus were not fully independent However Measures 1 and 2 correlated well with each other even though based on quite different kinds of behaviour Our main Measure 3 gave results very closely related to those from Measure 2 and therefore related to those from Measure 1 (ie the measure based entirely on direct measures of threat and attack) This crucial conclusion is not affected by the fact that Measures 2 and 3 had elements in common

**TABLE A I The Frequency With Which Cocks Called At and Threatened or Attacked an Observer Standing in Front of Each Cage**

| | Frequency of calls a b & c | Percentage frequency of threat or attack none | low | medium | high |
|---|---|---|---|---|---|
| Oct (142 birds) | none | 53 | 0 | 0 | 0 |
| | low | 21 | 1 | 0 | 0 |
| | medium | 15 | 1 | 0 | 0 |
| | high | 6 | 1 | 1 | 2 |
| April (63 birds) | none | 25 | 0 | 0 | 0 |
| | low | 21 | 2 | 0 | 0 |
| | medium | 10 | 8 | 2 | 0 |
| | high | 5 | 6 | 8 | 14 |

Low frequency 1–33% medium 34–66% high 67–100% of observations
? X 3 contingency tables excluding birds which did not call and combining columns 2–4 were significant ($P < 0\ 001$) in both months Each set of data is based on 18 ten-second observations made during nine days

TABLE A II Number of Cocks Which Gave Frontal and Adjacent Calls* in Relation to Whether They Attacked or Threatened an Observer During 18 Ten Second Observations

| | Attacked or threatened observer | |
|---|---|---|
| | yes | no |
| October | | |
| Frontal calls only | 4 | 15 |
| Adjacent calls given | 3 | 50 |
| April | | |
| Frontal calls only | 20 | 24 |
| Adjacent calls given | 4 | 13 |

*Frontal – cock called when observer in front of its cage Adjacent – cock called when* observer in front of the next cage but not in front of cock s own cage

October Fisher exact probability 0 116 April 0 114 combined $P < 0\ 1$

AGGRESSIVE BEHAVIOR
Volume 5 pages 85–91

# Book Reviews

## Play and Aggression by Donald Symons New York Columbia University Press 1978 pp x + 246

This book opens with a report on field observations of social play among young rhesus monkeys who live freely on an island off the coast of Puerto Rico The description encompasses the structure of social play patterns and an analysis of the age and sex of the participants Far from being the raison d etre of the book however this description is but an hors d oeuvre for seven chapters of discussion on the function of aggressive play among rhesus monkeys and certain other mammals

The essence of Symons thesis is that the adaptive function of behavior (in this case play fighting) may be gleaned from the structure of the behavior even in the absence of experimental proof He argues convincingly that the play fighting of young rhesus monkeys is *designed* as practice for certain skills used by adults during fights Although the monkeys seldom fight (about once a month on average) their position in the troop depends on performance during these rare fights Ultimately aggression must pay off or long ago the meek would have inherited the earth The goal of play fighting is to deliver gentle bites to the partner while avoiding being bitten The skills practiced during play fighting are how to maneuver oneself into a favorable position for biting and how to counter one s partner s maneuvers Symons asserts that to be given serious consideration alternative hypotheses regarding the function of aggressive play must satisfactorily account for its design I am sympathetic with his faith in the design of play behavior as an indicator of its function Certainly the experimental school has not flourished in the field of play whereas Symons approach carries us a worthwhile distance on the strength of observation intuition and common sense

Indeed I felt that the strongest of Symons arguments is that based on the declining human art of common sense For example he explains that it is nearly impossible to describe the most salient features of rhesus play fighting in traditional ethological terms because the fighting is a graded series of muscular movements endlessly variable in which each partner continually counters the other s moves with ever increasing skill The ethologist may indeed be unable to detect the most significant movement strategies since he or she is probably not an expert

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play fighter Of course this comment might be made on other forms of professional criticism besides ethology

During the discussion the reader is taken on a guided tour of prevailing ethological notions on mammalian play With chilling (and overdue) use of the common sense weapon Symons pares away many of the current clichés concerning play One such concept which seems to underlie much misunderstanding of playful behavior is the structural comparison that ethologists as opposed to young animals make between play fighting and fighting

In the popular academic view actions such as biting during play are accompanied by specialized metacommunicative signals which constantly remind the partners that the actions are not serious In the simian view as interpreted by Symons however play biting and biting are altogether physically different modes of mouthing contact Monkeys can communicate about what they are doing with communicating about what they are not doing The ethologist may not use the same cues as the young monkey to distinguish play fighting from fighting The distinction may not even be important to the young monkey who hardly ever fights in any case

More serious pollution of the literature on animal play is caused by the idea that a prominent function of play is to generate novel behavior patterns Symons conducts a richly deserved and dignified funeral service for this idea The basis for the novelty theory was the seeming variability in the combination of different motor patterns during play when compared with serious behavior From such juvenile experimenting novel behavior could even must arise From his observations however Symons believes that play fighting results in all monkeys learning the same or very similar tactics In other words play trains monkeys to be highly skilled conservatives

I have one major criticism The subject is largely the function of play fighting by a single species and in this limited context it makes at least to me excellent sense From the start of the discussion however Symons falls from grace by using the bald expression play as either an intentional or unintentional substitute for play fighting by young rhesus monkeys This discreet sliding from the particular to the general is quite unjustified since almost all the illustrations he uses are from rhesus monkeys and a few other primates and an occasional carnivore By making this generalization Symons manages to create or to *perpetuate a controversy which need not exist He says (p 101)* 'That by playing animals practice and perfect specific skills would seem to be so obvious as to be nearly beyond dispute to many observers of animal play yet it is not widely accepted and many students of play maintain that there is good evidence against it Symons has momentarily forgotten that there are many kinds of mammal besides Primates and Carnivora these different mammals may and do sometimes play in a manner quite different from that of rhesus monkeys and their play may have a different function

Much of the discussion in this book could have been written without Symons own observations with which the book opens literature already published would largely have sufficed The author however evidently developed his uniquely intuitive grasp of play fighting from his personal experience of watching There fore I feel the detailed presentat on of his results in the book is justified

To the dwindling minority who still pick up an ethological volume in anticipa tion of pleasure I recommend this book Not only are the photographs evocative of the play mood and the pro e delightful but the social role of football in England is discussed most intelligently in the later pages and there is also a photograph of a rhesus monkey sitting in a tree reading

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Analysis of Delinquency and Aggression edited by Emilio Ribes Inesta and Albert Bandura Hillside New Jersey Lawrence Erlbaum 1976 pp v + 273

This book contains the papers given at the Third Symposium on Behavior Modi fication held in January 1973 under the auspices of the Department of Experi mental Psychology and Methodology of the National Autonomous University of Mexico The symposium was planned around two themes namely the experimen tal analysis of aggression and the application of learning principles to preventing and modifying delinquency

The ten papers each stand as individual contributions They provide discussion on sociological issues in the control of human aggression and delinquent behavior (by E Ribes Inesta) discussion of some of the problems raised by experimental research on aggression by animals in laboratory settings (by J D Keehn) and on the technology for measuring and modifying transgressive behavior (by R Schitz gebel) they give descriptions of the use of certain corrective techniques for delin quents in institutional environments (by B Domingues et al and by I Sarason) and of preventive measures introduced into the environments of aggressive and delinquent young people (by J D Burchard et al by J B Reid and G R Patter son by H L Cohen and by E L Phillips et al ) and finally they include a presen tation of social learning theory (by A Bandura)

The theoretical position taken throughout the book is that human aggression and delinquency are social responses which can be fully controlled given an ap propriate social environment Evidence for this belief is put forward in several pa pers principally in the contributions by the editors They contrast it with other

theoretical viewpoints which present aggression as a drive as an urge released by organismic or environmental events or as a response to frustration Bandura considers that the explanatory power of theories such as these is small whereas social learning theory can provide a general system sufficient to cover all facets of aggression

There is no doubt that social learning theory has been helpful in planning strategies by which violence and delinquency may be reduced The projects which describe social interventions designed to reduce aggressive behavior all report promising results It is however noteworthy that each project presented at the symposium is for one reason or another on a small scale that some recalcitrant subjects were met and that there is no discussion of possible factors that might distinguish responsive subjects from nonresponsive

One is left with the impression that the contributors tend to be overoptimistic about the extent to which violence and delinquency can soon be eliminated by social engineering For instance Ribes Inesta adovocates the control if not the elimination of human aggression through far reaching social changes in which a) social wealth is equally distributed b) aversive controls are eliminated and c) violence is no longer legitimized as a means of appropriating socially produced wealth He does not however discuss possible strategies through which social scientists would deal with the aggressive reactions that tend to arise whenever established life styles are threatened by change

Nevertheless as Schitzgebel says effective practice does not necessarily require valid explanatory statements These papers have much to recommend them the book will be found helpful by all who are dealing with problems of human aggression and who are interested in finding alternatives to punishment in handling delinquent children and adolescents It is well produced and easy to refer to

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## Children In Conflict Growing Up in Northern Ireland by Morris Fraser New York Basic Books 1977 pp ix + 167

There have always been two populations in Ireland The original inhabitants have been supplemented by waves of Protestant settlers from England and Scotland who came on their own account or were planted in the sixteenth and seventeenth centuries by the English government There has always been trouble

between them The present eruption dates from 1969 and differs from the others only in that up to date technology has been added to skill in fighting with improvised weapons The current situation in Ulster has been ascribed by Thomson [1976] in his history of an Anglo-Irish Family planted three centuries ago in Sligo to segregation the inability of natives and settlers to live together in one society the settlers fear and their determination to hold exclusive power These he believes are the causes of violence now as they were in 1798

This is also the thesis advanced by Dr Fraser in his book Children in Conflict His experiences as a child psychiatrist in Belfast have led him to the view that the Ulster conflict is not a holy war between equals but a situation which arises anywhere in the world where ethnic minorities are discriminated against by insecure majorities The flash point comes inevitably when both the size and economic situation of the minority begins to approach that of the majority At that point any protests by the minority against the discriminating tactics of the majority are met by aggressive reactions on the part of the majority and the fight is on

Dr Fraser s evidence comes from a study of figures for psychiatric admissions outpatient attendance and drug prescription rates from the analysis of interviews with some 250 children from observation of the behavior of the public and the media and from a review of the literature on the effects of wars and riots on children

Dr Fraser s theoretical stance is eclectic He considers it beyond the scope of the book to review the many theories about aggression which he feels break down when an attempt is made to fit a single theory to all situations In order to understand the violent gang behavior of children in the Ulster setting he suggests a three stage sequence that he considers applicable in most areas where ghetto youth finds itself in conflict with authority There has to be a presence such as a British soldier that the child defines as a bogeyman fear has to be aroused to a point where the child is obsessed with fantasies of getting rid of the bogeyman and then given specific conditions and cues these fantasies are translated into action

The findings show that ill effects particularly on children come from living in a state of constant expectation of personal damage and of loss of family home and friends – especially when family friends and the media by their behavior and remarks contribute to the state of apprehension

Two profiles of children especially at risk have been identified One is exemplified by children often girls about 10 years old They have always been prone to physical illness and overanxiety they are economically deprived one parent is absent or chronically ill and one adult in the immediate family has crippling symptoms of anxiety and is given to ruminating aloud on past and future catastrophes

The second profile describes the young terrorist It is exemplified by boys in their early teens who are economically deprived with one parent involved in the

Republican movement or interned These boys are mentally preoccupied by thoughts of conflict have no other interests are leaders of gangs and direct hostility towards all authority including parents

Children in Conflict" is a well written book and useful despite the absence of an index It is to be recommended to politicians as well as psychologists sociologists and psychiatrists Dr Fraser s views and findings deserve further study Should they be confirmed not only will our understanding of the roots of civil violence be improved but also our power to reduce it

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## Civil Commitment and Social Control by Martin L. Forst. Lexington Massachusetts Heath 1978 pp vii + 175

The Civil Commitment Statutes in Anglo Saxon legal systems are currently u der review by scholars and legal philosophers who try to assess their effectiveness in dealing with specific classes of deviants Originally these laws had benevolent and h [illegible] tarian goals But as various scholars in the field have pointed out lack of proce[illegible] al safeguards has led to abuses and mismanagement

The book by Forst reviews the application of one such enactment California s "mentally disordered sex offender (MDSO) statute The research has been con[illegible] in three counties (Contra Costa San Francisco and Orange) by analysis of offi[illegible]al records interviews of key decision-makers and the use of a questionnaire given also to decision makers including an evaluation of the gradient of offence severity The history and the use of MDSO statutes are also reviewed The application of MDSO provisions does not vary greatly in the three counties although some disparities a[illegible] noted

It appears that th MDSO civil commitment has now been criminalized to a degree that makes it indistinguishable from criminal sanctions After the "triabil [illegible] " the case is assessed and after plea bargaining a sanction matching the "going ra[illegible] in the state is selected Consideration of the needs of the individual which sho[illegible] be the main (or only) factor for the use of the MDSO are minimal MDSO com[illegible] ments range in severity from imprisonment in the county jail to a sentence to s[illegible]

prison Normally the offender stays at Atascadero (the institution for MDSO offenders) for about two years Opinions on the effectiveness of therapy available at Atascadero are not optimistic When the Atascadero staff began recommending offenders for earlier discharge the Supreme Court began to impose additional criminal penalties to avoid a reduction in time served Essentially the time in detention either criminal or civil seems to be the crucial factor in policy on sentencing

In practice therefore there are not two separate sanctioning systems but only one The defense attorneys seem to be fully aware of the situation and to use it to secure release of their clients by intervening at the (estimated) appropriate time regardless of the merits of the particular case

The author formulates sensible policy recommendations Both for humanitarian and for practical reasons he does not advocate repealing the MDSO statute He believes however that MDSO commitment should be voluntary It should be raised as a sentencing alternative only by the defense just as with criminal insanity An alternative recommendation is that provision should be made to ensure that the duration of the civil commitment should not exceed the statutory maximum of a criminal commitment Since most of the cases are felonies this would not alter current practices but the risk of excessive sentences for misdemeanors would be avoided The Atascadero staff should also periodically assess the patient s progress and inform the court

Greater procedural protection is given to mental patients and to offenders under civil commitm nt and this trend is likely to continue This is in keeping with similar trends in the juvenile justice system as is evident in the Gault case Another trend is to require strict standards of proof (as in criminal cases) for decisions on civil commitment

Various recent cases involving these and related issues are discussed in detail in the concluding chapter The author considers correctly in my opinion these trends to be favorable Criminalization of the "civil commitment procedures would increase procedural and substantive protection in civil commitment law decrease disparities and reduce inconsistencies due to the use of discretion In spite of the small sample reported the book is recommended as one of the few existing empirical studies of an important problem Such research should be repeated elsewhere

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AGGRESSIVE BEHAVIOR
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# Genotype and Environment in the Social Interactions of Wild and Domestic "Norway" Rats

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Wild rats Rattus norvegicus (a) trapped as adults or (b) of the second generation in captivity (lab wild) and domestic rats of two strains were studied for 28 days in artificial colonies in large cages with attached nest boxes Controls were kept in mated pairs in small cages Each colony consisted of six males and six females. The interactions of the males in six colonies of trapped rats were highly "stressful " 61% died and most of the survivors lost weight and had greatly enlarged adrenals In each colony however there was a male (an alpha) that gained in weight and spent much time during the dark hours in the open on the floor of the cage and in three colonies there were also other males ("betas ) that gained in weight The adrenals of alphas and betas weighed about the same as those of the controls In one of the 12 colonies of domestic rats one male behaved like a wild male but in the other colonies the males gained in body weight and their adrenal weights resembled those of the controls In three colonies of lab wild rats 227 of the males died but there was no evidence of males of different status The findings confirm that the "agonistic" behavior of domestic rats is usually much attenuated in comparison with that of the wild type a number of methodologic implications are discussed

Key words aggression wild rats domestication territory agonistic behavior adrenals

## INTRODUCTION

Rattus norvegicus the common brown or Norway rat occurs in most regions of the world as a commensal with man and hence as a serious pest It is also universal in centers of learning as the laboratory rat The attribution of laboratory rats to this species is based on breeding The many strains of laboratory

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rats can interbreed and domestic rats can be crossed with wild R norvegicus Features of the behavior of such hybrids have been described by Stone et al [1932] Barnett [1960] and Boreman et al [1972] They tend to be intermediate between the parental types

There are however differences of opinion on the social conduct of the domestic varieties especially their aggressive behavior and on the category to which such behavior belongs Barnett [1975] has stated that domestic rats differ from the wild type in that some components of threat (including attack) have been lost or greatly attenuated and the fighting that remains is usually immat and does not produce ill effects But some workers have described what they ca aggressive or agonistic acts among laboratory rats (for example Flannelly et al [1977] Grant [1963] Taylor [1976] These acts include allogrooming crawling over or under another rat adopting an arched back posture with flank presentation and mounting from the rear Taylor [1976] however remarks of his observations that attacks with biting were infrequent Blanchard et al [1977] have described exceptionally fierce clashes among laboratory rats but these occurred only after many weeks of special treatment

Two types of evidence are relevant to these apparently opposed positions 1) One is detailed quantitative description of actual movements in encounters wh can show whether there is a decisive behavioral difference between the two kind of rat The comparison should be between adult males that have been living in groups Isolation has complex effects that make interpretation of the resulting behavior difficult (reviewed by Barnett [1975]) In a typical attack by a vi oro wild male the initial approach is slow and is accompanied by urination and de fecation the hair is raised when close the attacker usually presents its flank to the other and briefly prances around on extended legs with the back arched (the threat posture ) the attacker then makes a sudden leap with repeated adduc tions of the forelimbs and a momentary bite [Barnett 1958a] Among domesti rats as far as we know this full sequence has not been observed Such rats may perform some components for instance the threat posture and other featu of encounters between males such as boxing (in which the two animals stand upright facing each other) also occur Allen [1977] has staged encounters be tween pairs of wild rats and observed a high incidence of attack In encounters between laboratory rats in identical conditions attack hardly occurred

2) Secondly encounters between wild males can produce in the animal atta a failure to eat a decline in body weight hyperactivity and enlargement of the adrenal cortex collapse and death even in the total absence of wou d ing (reviewed by Barnett [1975]) Such changes can be recorded without ambiguity In the account that follows we give information on body wei s mortality and adrenal weights but no detailed description of the accompa ing social interactions Our procedure allows exact statements on differen between the wild type and domestic forms in specified conditions Hence it

becomes possible to decide to what extent domestic rats display some of the characteristic changes of social stress [Barnett 1964]

Most of the problems of social stress in mammalian populations remain unsolved but in recent years they have been shown to have a wide scope Evidence comes from the work of von Holst [1969 1972b] on the tree shrew Tupaia belangeri The effects of intolerant behavior among male tree shrews closely resemble those observed in wild rats In addition the kidneys of attacked tree shrews develop pathologic changes [von Holst 1972a] Similar renal pathology has been observed among male long haired rats Rattus villosissimus after exposure to attack [Barnett et al 1975] and in exceptionally dense natural populations of the same species (J L Carstairs unpublished findings)

Our objectives therefore were mainly methodologic 1) To distinguish some of the effects of social interactions displayed by the two types of rat 2) to examine whether the problems of rodent social behavior can be effectively studied in experiments on the convenient domestic forms and 3) to put the behavior studied in its appropriate category

## METHODS

### The Rats

The wild rats were all of the species R norvegicus trapped in Sydney Those used for the first three colonies and their controls were taken as adults from a large population on a university campus Those of the other three colonies were trapped as young adults in a thriving colony associated with dog kennels

On arrival in the laboratory they were sprayed with a solution of 2 ml Maldison in a liter of water to remove ectoparasites They were then kept for at least two weeks in wire cages described by Barnett and Prakash [1975] designed for wild rats in groups of three of like sex For two weeks they received 0 1 gm Mebendazole powder (methyl t benzoyl 2 benzimidazole carbamate) in 100 gm food to remove endoparasites If there were signs of bacterial infection the rats received 0 5 gm tylosin tartrate in each liter of drinking water

In addition some wild rats of the second generation bred in captivity were studied separately They had been bred and kept in similar small cages according to the procedure described by Barnett [1958b] In this paper they are called lab wild rats

The domestic rats were of two strains both supplied by the John Curtin School of Medical Research One was agouti (wild type in color) the other was hooded They were kept in conditions similar to those for the wild rats but in groups of six or seven Their ages were from 24 to 32 weeks at the beginning of the experiment

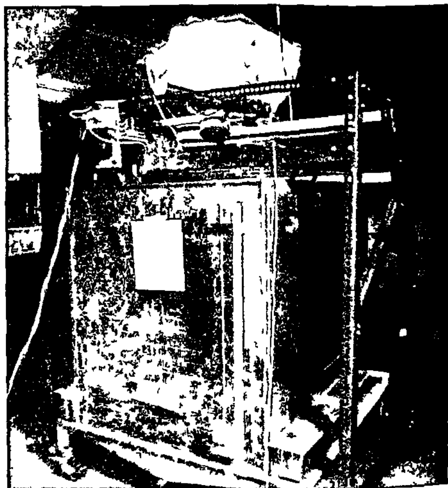


Fig 1 Colony cage equipped for time-lapse photography Two nest boxes are seen at bottom right The vertical column on the wall of the cage is a food hopper

## Equipment

Colonies were set up in cages of which the floors measured 100 X 80 cm The walls were 200 cm high At floor level there were entries to four nest boxes which provided darkened refuges for the rats Cotton wool was provided for bedding The top of each cage was open

Over it was suspended a camera set to take single flash light photographs of the cage floor at intervals of 30 min (Figs 1 2) The room with the cages was windowless Artificial light was on from 6 00 AM to 6 00 PM The camera was

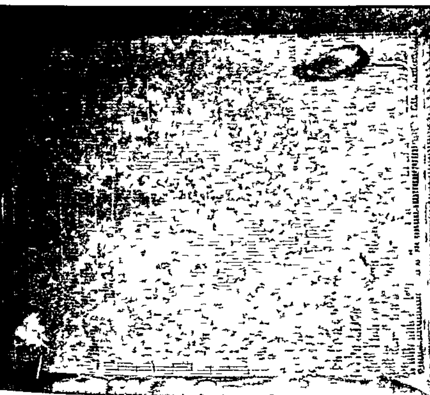


Fig 2 Colony cage from above A single wild male occupies the arena Bedding has been dragged out of nest box near the waterspout at bottom left

switched on from 4 00 PM to 8 00 AM on day 1 and on every third day there after throughout each experiment Apart from occasional failures the photo graphic record therefore covered the whole of the dark period and two hours before and after it on each of nine days.

## Procedure

Twenty-one colonies were set up three at a time The rats of each colony were all put in the cage together at about 4 00 PM There were six colonies of trapped rats and three of second-generation laboratory bred wild rats For convenience in distinguishing the sexes six colonies of domestic rats were of hooded males and agouti females and six were of agouti males and hooded females Corresponding to each batch of colonies (except those of the lab wild rats) there was a group of controls These were mated pairs in standard small cages each with one nest box of the same kind as those used for the colony cages Controls for the wild rats

were matched as closely as possible for body weight and origin Those for the laboratory rats were litter mates of the animals in the colonies A standard rat diet and water were available at all times

Each colony consisted of six males and six females all adults and all apparently healthy The males of each colony were from the same habitat but different holding cages All males were weighed to the nearest 1 gm marked with Durafur and put in the cage within a few minutes of each other They then remained in the cage for 28 days If a rat died the body was removed if it had very recently died it was weighed and a postmortem examination was made as described below At the end of the experiment all surviving rats were removed killed and weighed Wounds were recorded The adrenals were removed and weighed to the nearest 0 1 mg on a direct reading balance The lungs were examined for signs of infection

As a result of this procedure some of the figures of body and adrenal weights were of wild males that had been exposed to the experimental conditions for less than 28 days The observed differences from the controls would probably have been greater had all experimental rats survived for the full period

**Statistical Analysis**

Comparisons between colonies and controls and between different classes of animals in the colonies were by Student s t test two tailed Within class homogeneity of colonies and control groups was tested by one way analysis of variance This test showed the colonies of laboratory rats not to be homogeneous Hence in the statistical analysis the mean of each colony was treated as a single replicate

Covariance analysis was carried out to test for the validity of comparisons of the relative adrenal weights of different classes

## RESULTS

**Social Structure of Colonies**

**Trapped rats** Figure 3A illustrates some of the social interactions of wild rats revealed by the photographic record During the dark period even on day 1 it was unusual for more than one male to be out of the nest boxes at a time Often one appeared in a series of frames it was therefore probably in the open on the floor of the cage continuously for many hours Such a male we call an alpha We do not however imply by this the existence of a typical status system ( dom[illegible] hierarchy ) in these colonies Direct observation showed that alphas attacked [illegible] males in the manner described in previous studies (see Barnett [1975])

Although a male was out for most of the night on nearly all days in three of the six colonies it was not always the same male in those colonies we call only the male that was out during the later part of the experiment an alpha

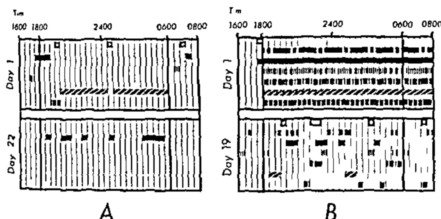



Fig 3 Examples of records provided by time lapse photography Photographs of the floor of each lar e cage containing a colony were taken at intervals of 30 minutes throughout the dark period and for two hours before and after dark The six males of a colony are each represented by a horizontal bar of a distinctive pattern A bar indicates the presence of a rat in the frame exposed at the time indicated A Record of a colony of wild rats on days 1 and 22 On day 1 only one male was out frequently This male was later displaced by another and the latter was the only male to appear in the record on day 22 B Record of a colony of domestic rats on days 1 and 19 On day 1 all males were out on the floor of the cage at all times after dark fall On day 19 all males were out frequently during the dark period

Females (which were not individually identified) behaved quite differently At least one could be seen in almost any frame and often two or three There was therefore no evidence of any social restriction on their movements

**Laboratory bred wild rats** The behavior of the lab wild males was different On day 1 all males were frequently out on the cage floor even during the dark period On later days however the pattern resembled that of the wild colonies In one colony a single alpha had emerged by day 4 in a second colony all males were still frequently out on day 4 but there was an alpha from day 7 In the third there were two alphas from day 4 to the end

The lab wild females behaved in the same way as the wild females

**Laboratory rats** The laboratory rats of both types (Fig 3B) behaved like the wild females On day 1 the exploratory tendency had full scope At any time during the dark period several males and females were always out Sometimes groups of both sexes slept in the open on accumulations of cotton wool There was no evidence (except in one colony) of differences in status

In the exceptional colony (RwL) the males were of the agouti type One male was an alpha throughout The females as in the colonies of wild rats we affected

TABLE I Mortality in the Colonies

| | No rats of each sex | Mortality | | Mean days to death (range) | |
|---|---|---|---|---|---|
| | | M | F | M | F |
| Trapped | 36 | 22 | 10 | 14 5 (1–28) | 17 9 (13–23) |
| Lab-wild | 18 | 4 | 1 | 22 25 (17–27) | 16 |
| Domestic | 72 | 4 | 0 | 13 25 (10–20) | – |

### Mortality and Body Weights

**Trapped rats** Table I gives the numbers of deaths in the colonies There were no deaths among the controls kept as mated pairs The main feature was the high death rate (61%) among the wild males The trend over time for each colony was toward a group of thriving females and only one male and in fact in three colonies only one male survived the alpha This confirms previous findings on rats of the same species trapped in Scotland [Barnett 1958a] There was however a higher death rate (28%) among the females than that observed before Many surviving males and some surviving females had superficial injuries usually of the tail There was no evidence of respiratory disease in any of these rats

Mean changes in body weight are given in Table II For this analysis the survivors from the colonies are divided into two groups those that gained in weight and those that lost (omegas) All alphas gained in weight In addition in colony E a second male and in colony F three other males did so In terms of change in body weight and of organ weights the alphas and the four others (which we call betas) form a single class distinct from the omegas All the controls gained in weight

Table II also gives initial and final weights The mean initial weight of the alphas plus betas was much above that of the omegas Evidently survival was positively correlated with superior weight

**Laboratory-bred wild rats** Four of the 18 males in the lab wild colonies died (Table I) There was no evidence of respiratory disease in any of them All the females survived All males lost weight Hence body weights gave no grounds for separating these males into two classes

**Laboratory rats** Of the 12 colonies of laboratory rats there were deaths in only three (Table I) One male died in colony B and two in colony C on examination of the lungs all these were found to have extensive chronic respiratory disease One male died in colony H for no known cause

In all colonies of domestic rats except one the males (apart from those that died) gained slightly in weight (Table II) Among the agouti rats there was no

TABLE II Body Weights of Males (Means ± SE)

| | Colonies | | | | Controls | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | Initial wt gm | Final wt gm | % Change | N | Initial wt gm | Final wt gm | % Change | P<[a] |
| Trapped | | | | | | | | | |
| α | 10 | 419.2 ± 30.0 | 454.5 ± 29.8 | +7.9 ± 1.5 | | | | | 0.2 |
| ω | 13 | 324.9 ± 25.8 | 267.7 ± 23.3 | −17.0 ± 3.2 | 18 | 360.9 ± 18.2 | 381.1 ± 20.2 | +4.9 ± 1.1 | 0.001 |
| Lab wild | 14 | 392.0 ± 20.0 | 338.9 ± 18.3 | −12.9 ± 2.0 | | | | | 0.001 |
| Hooded[b] | 6 | 253.2 ± 7.1 | 257.2 ± 8.4 | + 1.3 ± 1.3 | 24 | 253.6 ± 3.9 | 270.3 ± 4.7 | +6.0 ± 0.9 | 0.05 |
| Agouti[b] | 5 | 247.7 ± 1.9 | 254.2 ± 1.9 | + 2.6 ± 0.8 | 24 | 245.2 ± 6.1 | 254.0 ± 5.6 | +3.7 ± 1.5 | 0.8 |
| Colony RwL | 6 | 255.5 ± 7.0 | 227.7 ± 12.0 | −10.2 ± 2.3 | | | | | 0.001 |

[a]Comparison of percentage changes of colonies with those of controls
[b]Each colony of these classes is treated as a single replicate

dence of any difference in this regard between the colony members and the controls But the hooded laboratory rats in the colonies gained less weight than the corresponding controls

In the exceptional colony (RwL) the males were of the agouti strain Although there were no deaths this colony resembled a colony of wild rats in important respects Only one male gained in weight This male was initially the second heaviest of the colony (268 gm) the heaviest was 286 gm At the end of the experiment it had gained 6% in body weight and it was the only male in good external condition without bites Hence in the analysis that follows colony RwL is treated separately from the others

### Adrenal Weights

Mean adrenal weights are given in Table III Those of the alphas and betas did not differ from the control value but the adrenals of the omegas had evidently undergone a marked hypertrophy The differences from both the alphas and betas and the controls however calculated were statistically highly significant The adrenal weights of the lab wild rats were intermediate between those of the

**TABLE III** Adrenal Weights of Males

| | Colonies | | Controls | | |
|---|---|---|---|---|---|
| | N | Mean ± SE | N | Mean ± SE | P < |
| | | Absolute weights mg | | | |
| Trapped | | | | | |
| $\alpha + \beta$ | 10 | 101.3 ± 11.1 | | | 0.2 |
| $\omega$ | 13 | 123.1 ± 6.9 | 18 | 86.6 ± 3.5 | 0.001 |
| Lab wild | 14 | 110.3 ± 6.9 | | | 0.01 |
| Hooded | 6[a] | 49.4 ± 2.0 | 24 | 51.8 ± 2.6 | 0.7 |
| Agouti | 5[a] | 39.6 ± 1.1 | | | 0.7 |
| Colony RwL | 6 | 46.1 ± 4.1 | 24 | 37.9 ± 1.5 | 0.05 |
| | | Relative weights mg/100 gm | | | |
| Trapped | | | | | |
| $\alpha + \beta$ | 10 | 22.0 ± 1.2 | | | 0.6 |
| $\omega$ | 13 | 48.8 ± 4.2 | 18 | 24.0 ± 1.3 | 0.001 |
| Lab wild | 14 | 33.4 ± 2.4 | | | 0.01 |
| Hooded | 6[a] | 19.5 ± 0.9 | 24 | 19.4 ± 1.1 | 1.0 |
| Agouti | 5[a] | 15.8 ± 0.5 | | | 0.5 |
| Colony RwL | 6 | 20.3 ± 2.1 | 24 | 14.9 ± 0.5 | 0.001 |

[a]Each colony of these classes is treated as a single replicate

wild alphas and betas and those of the omegas Among the laboratory rats once again th only effect of the experimental treatment was on the adrenals of colony RwL

## DISCUSSION

### Experimental Design

The defects of the work described above arise from its inadequate scale im posed partly by the difficulties of getting wild R norvegicus in Australia In our experiments there were two sources of variation 1) Genotypic (wild contrasted with domestic) and 2) environmental (reared in freedom or in captivity) In its simplest form this gives a 2 X 2 de ign Unfortunately one cell was missing – domestic rats reared in freedom Moreover for a comprehensive account of the effects of both variables the number of cells would need to be increased in both dimensions for the following reasons

1 There are not two genotypes but many Wild rats are genetically diverse We know little of how the diversity influences behavior but selection in the laboratory intentional or inadvertent has frequently revealed it (reviewed by Barnett [1975]) Laboratory rats too vary genetically in many ways between strains [Robinson 1965] The two types of successful rat in the wild colonies may reflect genetic differences Barnett [1958a] described wild males called betas which survived and grew well in artificial colonies despite the presence of an alpha that tended to attack all other males The betas did not attack intruders and they withdrew on the approach of an alpha Nothing is known of what enables such rats to survive when other males do not

2 There is an important environmental effect easily overlooked – the nurture provided in utero and in the nest by the mother and sibs Our lab wild rats were of the second generation reared in captivity They were therefore products of selection in captivity rearing in captivity and the maternal environment pro vided by females of the first generation reared in the laboratory These females in turn represent a population differing from the original wild population a) They had been reared in captivity b) they were the result of selection at two stages – first trapping is not a random process but selective and second only some females are fertile in captivity

### The Category of Behavior Studied

Another question of method concerns the kind of behavior we studied It is commonly referred to as aggressive but this term is now used so indiscriminately that it covers nearly all social interactions as well as some which are not social such as predation

The conditions in which the colonies were kept allow wild rats to thrive unless there are special sources of conflict [Barnett 1958a] hence death and other ill

effects (including adrenal hypertrophy) cannot be attributed to the nonsocial features of the environment Our findings therefore concern measurable effects of social interactions Previous work cited in the introduction had also shown how in dyadic encounters threat by a conspecific can lead to loss of weight adrenal enlargement and death By threat we mean a signal or display that tends to cause the withdrawal of a conspecific *This definition includes actual attack and biting* (or other wounding) for these can presumably induce withdrawal Threat in this sense is usually performed by adult male wild R norvegicus in a familiar place it is directed toward newcomers (which must also be adult and male) It is therefore territorial [Barnett 1958a] To call it territorial behavior is not to explain it as Moyer [1976] supposes but to classify it It is territorial by definition

## The Effects of Domestication

Our findings allow some conclusions (summarized in Table IV) both on the differences between wild and domestic R norvegicus and also on the effects of breeding wild rats of this species in captivity For comparison with the wild type the two strains of laboratory rats though different in detail may be treated together (colony RwL excepted)

The contrast in behavior between the domestic and wild types is confirmed In each colony of wild rats a single male behaved on the floor of the ca e as if on its territory During most of the dark period other males were usually confined to the nest boxes Farr et al [1977] describe a similar effect of status relationships on the circadian rhythms of deermice Peromyscus maniculatus Th omegas as a result probably had only brief and irregular access to food That may have con

**TABLE IV** Males of the Experimental Colonies

| | Trapped | Lab wild | Domestic |
|---|---|---|---|
| Intolerant behavior | High | Low | Almost absent[a] |
| Two types of males distinguished by growth | In all colonies | None | In one colony |
| Mortality ( ) | 61 | 2 | 5 |
| Body weights | Reduced (alphas and beta excepted) | All reduced | All increased[a] |
| Adrenal weights | Much increased (alphas and betas excepted) | Increased | Unaffected[a] |

[a]Except one colony

tributed to their loss of weight and to other ill effects Such consequences of irregular meals have been observed in laboratory rats by Welker et al [1977] This cannot however account for the loss of weight of the lab wild males for their movements were not restricted by an alpha In the colonies of domestic rats (RwL excepted) there was no evidence that the movements of any rat were re stricted in this way Both the lab wild and the domestic rats (except in one colony) were nonterritorial

In the wild colonies there was a distinction between the alphas and betas on the one hand and the omegas on the other The former differed from the omegas not only in their behavior and increase in body weight but also in the weights of their adrenals which resembled those of the controls Adrenal hypertrophy represents a physiologic response to adverse external conditions In that sense it may be called an index of stress [Vogt 1954] Only the omegas of the wild rat colonies had greatly enlarged adrenals their adrenal weights resembled those of the attacked wild rats described by Barnett [1958b] In this early work the attacks were by males resident in a large cage and were directed at strange males (intruders) The behavior (reviewed by Barnett [1975]) is described in detail It is still not known whether adrenal hyperactivity in such conditions is adaptive Except in colony RwL there was no evidence of adrenal hypertrophy in any of the domestic rats

The exceptional colony (RwL) though an isolated instance is methodologically important Even in a closed breeding stock there was sufficient variation for one of six colonies to differ decisively from the rest Evidently the difference arose from the presence of a single male that behaved rather like a wild male We do not know the proportion of such males in this (or any other) strain or whether its difference from the others was genetically determined The existence of such males in varying proportions in different domestic stocks could account for con flicting experimental findings

Another significant methodologic observation concerns the lab wild rats Barnett et al [1969] reported results of breeding wild R norvegicus for six to nine generations in the laboratory Attack time and the incidence of the arched back threat posture recorded in standard conditions were greatly attenuated In our experiments even two generations in the laboratory had measurable effects The pattern of social interactions in the lab wild colonies was more like that of domestic rats than that of the trapped wild rats mortality was lower among the trapped rats and adrenal hypertrophy was slight or absent

Price [1978] has compared trapped R norvegicus with the first generation bred in captivity The encounters were each between a resident adult male and a strange intruder The trapped males threatened much more than the first generation males His findings therefore conform with ours and as Price states they suggest that the laboratory environment is a major source of the differences observed Price [1977] also gives evidence that male wild R norvegicus of the

first generation reared in the laboratory are less likely to make burrows than are males trapped in the wild domestic rats burrow even less His findings suggest that the laboratory environment reduces the propensity to burrow but that the difference of domestic from wild in this respect is mainly genetically determined

There is evidence of variation in the rates over generations in captivity at which different kinds of behavior alter There is marked difference between wild and domestic rats in the avoidance of unfamiliar objects in a familiar place or neophobia [Barnett et al 1976] but unlike the social interactions described in the present paper neophobia persists for at least twelve generations in captivity [Cowan 1977] Furthermore Price et al [1977] observed the maternal behavior of wild and domestic (albino) females at several stages after parturition and found little difference

The lability of the intolerant behavior of wild rats illustrated by our findings is not confined to R norvegicus J L Carstairs (unpublished observations) has made similar observations on R villosissimus Trapped males have been compared with males of the first generation reared in the laboratory those reared in captivity were slower to attack and threatened less than the trapped males His animals were taken from exceptionally dense probably still growing populations and they may therefore have been genetically unusually diverse but the extent to which genetic differences influenced his findings is not known Rigorous experiments are needed on both the genetic and the environmental factors responsible for such changes

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AGGRESSIVE BEHAVIOR
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# Aggression, Crying and Physical Contact in One- to Three-Year-Old Children

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In a longitudinal study in which 59 first-born middle class children were observed in the company of other children of the same age and with their mothers a high frequency of attacks on other children by children nearly two years old was correlated with absent or delayed response by the mother to the child s crying after falls etc Other aspects of mother s or child s behaviour were examined but all failed to explain away this correlation Some routes by which the correlation could have arisen from immediate influences of the child s behaviour upon the mother were also excluded Thus it was not true that "tough" kids fight a lot and stop crying quickly Nor did mothers respond less to children who cried often

Key words peer peer interaction mother-child interaction aggression crying attachment

## INTRODUCTION

Most research on aggressive behaviour in animals concerns the causes and consequences of normal aggressive behaviour In contrast this paper like much other research on aggressive behaviour in children concerns individual differences Interest in child development traditionally centres on explaining the extremes of normal variation We think the distinction is important explanations of abnormal aggressive behaviour and of individual differences in aggression could be very different

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from explanations of the occurrence and development of normal aggressive behaviour Smith and Connolly [1974 1978] have conducted a series of studies of environmental factors that influence the rates of aggression in preschool child as a whole Patterson and colleagues [1973 1974] on the other hand have car out an important series of studies on troublesome levels of aggression in childre and Manning et al [1978] carried out an important study of individual styles of gression This paper follows in the latter traditions to the extent that it concerns correlates of individual differences in aggression and examines some hypotheses about the causes of the individual differences

We want to know why some children show much higher frequencies of aggres than others By aggression we mean simply the number of occurrences of the fol lowing hits bites pulling hair kicking pushing another child taking an object from another child pulling at an object that another child has Blurton Jones [19 and others have shown that these vary together with each other but occur indep ently of other patterns best labeled play fighting or rough and tumble " Des criptively the behaviour of the few most frequently aggressive children in our s resembled the unprovoked assaults discerned in earlier data on 3–4 year-olds here by Burke (unpublished) and independently described and traced by Mannin in children from 4–7 In our experience of toddlers these assaults are noticed by the mother of the aggressive child and are distressing to her Even in the absence of any firm demonstration of long term consequences this is reason enough to p voke further investigation of influences upon this behaviour The behaviour with which we are concerned should not be confused with unruly hyperactive be haviour which is sometimes called aggressive

During a longitudinal study of attachment social behaviour and language dev ment we noticed that children who were noteworthy for the frequency and style their aggressive behaviour to other children also had unusual patterns of physical contact with their mothers We particularly wished to test in our data the impres sion that crying by the aggressive children less often led to physical contact with mother than in the less aggressive children

Any observed correlation between parent behaviour and offspring behaviour r be investigated in at least two directions 1) determining whether the correlation primarily between these two measures or is more closely between some other ass ciated pair of parental and child measures (see hypotheses 2 and 3 below) and 2) attempting to ascertain the direction of causation if any underlying this parti lar correlation (see hypotheses 4 and 5 below)

Since it is safe to assume that development of a mother–child relationship is a constant process of two way interaction and since no statistical technique can de with these circular relationships any testable hypothesis about direction of caus underlying a correlation is bound to be an over-simplification However a simp causal hypothesis is at least falsifiable One can test whether a particular hypo

can be excluded The status of causal theories of mother–child interaction is thus exactly like that of any other scientific theory it generates falsifiable hypotheses but can itself never be proved true A view that emphasises the total entwined ness of the relationship may feel more true and may even allow empirical prediction from one age to another But parents believe they have some influence on their children and some control over whether they behave one way or another They daily ask for advice from health visitors general practitioners teachers If psychology is to improve the empirical evidence behind the advice given it has either to tell parents that they cannot change their own behaviour because it is part of a totally entwined system of interaction or it has to risk employing causal models in research The causal models will at first be too simple and because they are hypotheses capable of disproof often wrong But eventually and after experimental study the causal approach may give useful answers This paper represents a very simple attempt to move towards testing causal models of individual difference on nonexperimental data

We have examined our data to test the following hypotheses

1) The child s aggression to other children is predicted by slow maternal response to crying

2) This relationship can be explained away by the higher levels of interaction with peers by aggressive children ie it is not specific to aggressive behaviour

3) That other features of the maternal behaviour particularly more severe punishment are more closely correlated with higher aggression and account for the correlation with response to crying

4) That slow maternal response to crying may be found in children reported by their mothers to have never liked physical contact (like those described by Schaffer and Emerson [1964a] and that these were also the aggressive children

5) That the persistence or frequency of the child s crying might explain the maternal response and its association with aggression (ie tough children cry briefly and fight a lot soft children cry long enough to get a response and don t fight)

One thousand and one other hypotheses have not been tested

## SAMPLE

Sixty firstborn children (fathers occupations in Registrar General s Social Classes I and II) were recruited through health visitors in three North London boroughs The sample comprised 34 boys and 25 girls first children of white British mothers and fathers There were no twins No mothers in full time employment were recruited Many were working part time or worked more as the study proceeded There were no children in single parent families and no second children had been born in the families when the study began

## METHODS

The first observations and interviews took place when the children were 15 months old and continued at 6 month intervals thenceforth Children and their parents were seen in a variety of carefully chosen situations for a total of about 2½ hours interview and 2½ or 3 hours observation at each age The measures used in this paper are described below The observations that provided the data reported here were at 15 months 21 months and 39 months and were from three group visits to the observation playroom at the Institute of Child Health at each age Each visit lasted about hours Four mothers and their children would come together to the playroom a nursery nurse was present for most of the session The mothers had coffee and orange juice after about 40 minutes and after a further spell of unstructured time specially arranged separation was arranged between two of the mothers and children in succession The data analysed for this paper come from 10 minutes of observation of each child during the initial unstructured period and 10 minutes from the second unstructured period a total of 40–60 minutes for each child at each age depending on how many sessions the child attended

Behaviour was recorded with pencil and paper as a string of two-letter codes corresponding to previously defined small observable items of behaviour or people Each verb (behaviour code) had an actor and recipient associated with it Distances and positions were recorded as verbs A time mark was put in the record every seconds in response to an automatic sound signal to the observer The method of observation was derived from that of Leach [1972] and the rationale of this kind of observation was described by Leach and by Blurton Jones [1972a 197 b] observer reliability was good for the more frequent items recorded The key behaviour with which this paper is concerned is very infrequent and it is scarcely practical to do the usual kind of reliability test Consequently we have treated the observers as an additional independent variable and examined their effect on the findings Two regression analyses are shown in Table III In each analysis one of the three observers is taken as a dummy variable and is entered first in the equation to see whether the central association that we report is really due to observer effects There is no influence of observer

Mothers were interviewed at home at each age about a variety of topics concerning their child This included questions about punishment and questions about attachment used by Schaffer and Emerson [1964b] and from these and other questions we sought information about the child s like or dislike of physical contact with mother Another section concerned with the mother s description of her child also covered physical contact

## THE MEASURES

In this paper we are concerned with a few measures some of which need careful definition

DELY (15 Months and 21 Months)

Maternal responsiveness to cry and arms up refers to the time from a record of the child beginning to cry or doing arms up (see below) to a record of the mother picking up the child onto her lap or into contact with her body We did not count putting an arm round the child leading it by hand standing it up onto its feet putting it onto a piece of apparatus or furniture Time was assessed in two ways Firstly by the number of behaviour codes in the record that intervene between the cry and the pick up An upper criterion was set of 24 codes This represents nearly half a minute and there were virtually no cases in which if no pick up occurred within this time it occurred subsequent with no further record of cry or arms up Most instances involve either an extremely rapid pick up (within 2–4 codes and well within the same 15 second block in the observation) or no pick up at all The second measure of delay was the number of times mother picked up the child within two 15 second time marks in the record from the start of crying The two measures correlate with each other very closely ($r = 0\,903$ $P = 0\,001$)

Episodes of cry and pick up are rare and one would expect the measure to be very inconsistent However the correlation between the 15 month scores and the 21 month scores was moderately high and statistically significant ($r = 0\,363$ $P = 0\,025$)

In our sample the responsiveness to cry was not related to frequency of crying episodes Thus one cannot argue that responsiveness was directly determined by the frequency of the child s crying (eg mother stops responding because the child is in a bad mood and cries so often or eg mother responds rapidly because it is unusual for her child to cry)

There is some evidence that crying that persists ie the child does not stop crying within 15 seconds is more likely to get a response However this is not an inflexible influence on mother response In an analysis of this measure of response to crying we found that persistent criers could receive either the slowest or the fastest responses depending on the mother s earlier history

Consequently we feel that our measure is worth working with containing a large component of variation due to differences between mothers rather than differences between the child s immediate behaviour We think it is important to discriminate between immediate effects of the child s behaviour and long term effects An example of the latter is the likelihood that mothers learn how readily their child stops crying with and without picking up

AVDLY

A combination of DELY15 and DELY21 If DELY15 was available for a child but there were no DELY21 (21 months old) data available then AVDLY was equal to DELY15 Likewise if only 21 month data were available AVDLY was equal to DELY21 If data were available for both ages AVDLY was (DELY15 + DELY21) divided by 2

**MUTC**

*Frequency with which mother speaks to child during the group observations*

**MAPC**

Frequency with which mother holds an object towards the child durin the gr observations

**MRN (Mother s Verbal Responsiveness to Vocalisations)**

From the solitary observations the proportion of child vocalisations (that were not crying fretting laughing or imitations of vehicles animals etc ) that led imme iately to mother speaking to child (but not with a prohibition) This measure of re ponsiveness is not correlated with DELY our measure of responsiveness to cry

## PICKING UP AS A CONSEQUENCE OF AGGRESSION

The observation data for the 15 months observations and the 21 months obser vations was searched for episodes in which the child attacking or taking things fro another child was followed within one minute by mother picking up the child Thi is the only measure of the consequences of the child s aggression that we have ex

***PCAS21 (at Age 21 Months)***

Percentage of behaviour items directed to other children that were aggressive items (ie hits bites push pull at an object in another s hand take object pu before the other releases the object and without the other proffering the object)

**AGG21**

Number of aggressive items (see above) performed by the child in one hour of observation

**PCF**

Percentage of records of distance between mother and child which are of more than 4 feet Records of child in physical contact with mother are included and count as less than 4 feet

**SOC 15 (At Age 15 Months and SOC 21 at Age 21 Months)**

Number of times in one hour of observation that child speaks smiles ap proaches or proffers to other children

**Obstetric History**

The number of minor obstetric problems (from the list given by Prechtl [10 during the mother s pregnancy and delivery reported by the mother during a

by item interview (This measure correlates Spearmans rank order correlation =0 65 $P<0\ 001$ and 0 59 $P<0\ 001$) with two independent codings of reports direct from the hospitals )

### Punishment

Children were classified using the interview data according to whether the mother said she ever smacked the child or not (70% smacked at 15 months 81% at 21 months) and whether she ever used punishments such as removing the child from the room where she was or confining it to its bedroom (6% at 15 months 19% at 21 months)

### Cuddler or Non Cuddler

Children were classified according to the mother s interview comments concerning physical contact in two separate parts of the interview Seven children were classified as resisting or disliking physical contact with mother

## RESULTS

### Hypothesis 1

Aggression at 21 months is correlated with slow response to crying at 15 months and at 21 months (Table I) Aggression at 39 months is associated with the combined 15 and 21 month response to crying ( AVDLY ) (medians test $X^2 = 4\ 6$ $P<0\ 05$) This hypothesis is mainly confirmed

### Hypothesis 2

Aggression at 21 months is correlated with amount of other social behaviour to children and with average distance from mother (Table II) Children who are far from their mother and are often interacting with other children also show more aggressive behaviour This hypothesis is therefore realistic

TABLE I Spearman Rank Correlation of Aggression (AGG21) and Percentage of Social Behaviour That Is Aggression (PCAS21) With Delayed Response to Crying at 15 Months (DELY15) at 21 Months (DELY21) and From Both Ages Combined (ADVLY)

| | DELY15 | DELY21 | AVDLY |
|---|---|---|---|
| AGG21 | r - 0 311<br>P = 0 035 | r = 0 328<br>P = 0 023 | r = 0 351<br>P = 0 011 |
| PCAS21 | r = 0 487<br>P = 0 00? | r = 0 420<br>P = 0 005 | r = 0 492<br>P = 0 001 |

TABLE II Spearman Rank Correlations of Aggression (AGG21 PCAS21) and Response to Crying (DELY21) With Child s Social Behaviour to Peers (SOC21) Distance From Mother (PCF21) and Frequency With Which Mother Speaks to Child (MUTC)

| | SOC21 | PCF21 | MUTC21 | MAPC15 |
|---|---|---|---|---|
| AGG21 | r = 0 625<br>P = 0 001 | r = 0 540<br>P = 0 001 | r = −0 276<br>P = 0 03? | r 0 3[illegible]<br>P 0 015 |
| PCAS21 | r = 0 074<br>P = 0 312 | r = 0 335<br>P = 0 012 | r = −0 395<br>P = 0 004 | r 0 14[illegible]<br>P 0 136 |
| DELY21 | r = 0 070<br>P = 0 338 | r = 0 178<br>P = 0 143 | r = − 0 291<br>P = 0 039 | r 0 [illegible]<br>P 0 056 |

However slow response to crying is not correlated with social behaviour or distance from mother (Table II) When forced into a stepwise multiple regression the measures do not remove the relationship between responses to crying and aggression (equations 1 and 2 Table III)

Aggression measured as a proportion of all social behaviour to peers (PCAS) is also correlated with response to crying (Table I) Thus mothers who respond slowly or not at all to crying have children in whom a higher proportion of their behav[illegible] to peers is aggressive This hypothesis is thus disproved In our data response to crying relates specifically to aggression and not to all interaction with peers

### Hypothesis 3

There is no correlation of aggression with the punishments reported by the mothers There is also no correlation of aggression at 21 months with the mother's readiness to respond to the child s vocalisations by speaking to the child when m[illegible]ther and child are alone The latter is closely related to language development a[illegible] IQ scores and verbal and object exchange interactions with mother and less cl[illegible] to responses to strange adults [Blurton Jones et al in preparation] There is a neg[illegible]tive correlation between aggression at 21 months (PCAS21) and the frequency [illegible] which the mother speaks to the child and proffers objects to the child in th[illegible] situation (Table II) Again one has to examine the role of the distance between m[illegible]ther and child in these associations When distance is entered first in a regress[illegible] equation predicting aggression (equation 6 Table III) the associations with m[illegible]ther speaks is reduced but does not disappear This is in direct contrast to th[illegible]ciation between aggression and response to crying (equation 5) Equations [illegible] show that if DELY21 is taken into account MUTC21 has no influence wh[illegible] the reverse is not true Equations 3 and 7 show that MAPC21 has no influence [illegible] either distance or DELY are taken into account To this extent we can say th[illegible]ponse to crying is the feature of maternal behaviour most related to a[illegible] this age group

TABLE III Summary Statistics of Regression Analyses Described in the Text

| Equation number | Dependent variable | First independent variable | Cumulative R squared[a] | Second independent variable | Cumulative R squared[a] | Overall significance |
|---|---|---|---|---|---|---|
| 1 | ACC21 | PCI21 P = 0.003 | 22.4% | DLLY21 P = 0.077 | 29.2% | F = 7.21 P = 0.002 |
| 2 | ACC21 | SOC21 P 0.000 | 57.2% | DLLY21 P = 0.010 | 64.5% | F = 31.8 P = 0.000 |
| 3 | PCAS21 | MAPC21 P = 0.187 | 4.7% | DLLY21 P - 0.019 | 18.8% | F = 4.05 P = 0.026 |
| 4 | PCAS21 | DLLY21 P - 0.009 | 17.6% | MAPC21 P = 0.474 | 18.8% | F = 4.05 P = 0.026 |
| 5 | PCAS21 | PCF21 P - 0.069 | 8.9% | DLLY21 P = 0.016 | 23.0% | F = 5.23 P = 0.010 |
| 6 | PCAS21 | PCI21 P = 0.025 | 10.8% | MUTC21 P - 0.078 | 17.1% | F = 4.45 P = 0.017 |
| 7 | PCAS21 | PCI21 P = 0.025 | 10.9% | MAPC21 P 0.738 | 11.7% | F = 2.69 P = 0.079 |
| 8 | PCAS21 | MUTC21 P - 0.035 | 11.8% | DLLY21 P = 0.033 | 22.7% | F - 5.13 P = 0.011 |
| 9 | PCAS21 | DLLY21 P = 0.009 | 17.6% | MUTC21 P = 0.139 | 22.7 | F = 5.13 P = 0.011 |
| 10 | PCAS21 | Observer 1 P - 0.921 | 0% | DLLY21 P = 0.010 | 17.6% | F = 3.74 P = 0.034 |
| 11 | PCAS21 | Observer 3 P = 0.316 | 2.8% | DLLY21 P = 0.005 | 22.5 | F = 5.09 P = 0.011 |

[a]Expressed as percentage of variance accounted for

The child s attacks on other children were only seen to lead (in the followin minute) to the mother picking up the child on 16 occasions This is such a min proportion of both the attacks and the picking up episodes that we can scarcel test and cannot claim any support for our suspicion that the very aggressive ch were reinforced by obtaining a significant proportion of their physical contact *mother as a result of attacks on children*

Thus hypothesis 3 was disproved with respect to the measures mentioned ab but of course these measures do not comprise every conceivable measure of pa behaviour

### Hypothesis 4

Seven mothers clearly described their child as not cuddly or not enjoying sical contact The remarks of a further two suggested that their child could be c fied in this way There was a nonsignificant tendency for these mothers to hav responses to crying These children did not differ from the others in their sco e gressive behaviour This hypothesis was therefore not confirmed

### Hypothesis 5

As we reported elsewhere [Blurton Jones et al 1978] crying persists more i children with sub-optimal obstetric histories (using the criteria of Prechtl [19 Also their mothers tend to respond more rapidly and often to crying But these children are neither more nor less aggressive than optimal children at 15 21 39 months of age

Categorising the children directly on their scores for persistent crying tells th story For example there is no difference in the proportion of persistent crying months between the children who show any aggression to peers at 39 months a those that do not The hypothesis that the correlation between aggression and m ternal response arises because tough children fight more and cry less persist is not confirmed There is no support for the more general hypothesis that the c stetric history of the child leads separately to different response to crying and to *usual levels of aggression*

## DISCUSSION

We observed that mothers who picked their child up after a delay or not at al after it began to cry or put its arms up had children who more often atta ked other children We showed that this correlation was specific to aggressive behav and was not general to all kinds of interaction with peers We showed that the c relation was with mother response to cry and arms up rather than with other maternal vocal and gestural behaviour or punishment as reported by the mother during interview

Nonetheless we feel that the hypothesis that features of mother other than these are closely related to aggression needs further study It is really a large family of hypotheses Interview reports of punishment may be inadequate and features of observable behaviour that we did not analyse may be important especially further aspects of the mother s responses to the aggressive episodes

We examined two hypotheses that explained the observed correlation as a result of features of the children and excluded them No doubt many others remain to be defined and tested Many other hypotheses about the correlation of response to crying and frequency of aggression have not been tested Much variation in the factors influencing the mother s response to crying has been ignored Since crying is such infrequent behaviour it is likely to be more productive to follow our findings with experimental studies with the cooperation of mothers of aggressive toddlers rather than by yet lengthier and yet more detailed observations

Even if the correlations that we observed do reflect an influence of the maternal behaviour at this age upon the child the question remains open as to whether the maternal behaviour at this age was in turn influenced previously by features of the child We have discussed the influence (contemporary and long term) of the more persistent crying of the obstetrically sub-optimal children Elsewhere [Blurton Jones et al in preparation b] we describe an interaction between the mother s own family history and the child s obstetric history in predicting the mother s response to crying and arms up We have commented that children reported by their mother as never having liked to be cuddled tended to get slower response to crying and arms up However we do know that some of these few children were cuddly with their father or sat comfortably on our laps on occasion It is by no means clear how the non-cuddly category develops but of course the mother s classification of her child as non-cuddly could either lead her not to pick it up or it could simply be a rationalisation of her reluctance to pick it up One major possible influence that we have not examined is the speed with which the child stops crying after it is picked up Moss [1967] presented indirect evidence that this was an influence on the response of mothers to crying

We know that several of the children markedly changed their frequencies of aggressive behaviour from age to age Despite an overall continuity some individuals changed markedly The same is true for the mothers in both directions Thus although Manning also finds individual consistency in styles of aggression in children from 4 to 7 years old it would be wrong to regard this as an irreversible feature of a 1–3 year-old child s behaviour Indeed elsewhere we shall present the evidence in our data that the consistency of the child s behaviour can be explained by the consistency in the mother s behaviour rather than vice versa

Very few studies have observed children of this age with their mothers and with other children We are thus unable to find anything comparable to our results in the literature The nearest is the observation by Montagner [1978] and Montagner

et al [1978] that aggressive-dominant children (noted for their frequent aggression and infrequent sociable behaviour) had mothers who interacted with them with few of the facial expressions and gestures classified by Montagner as "appeasing" (eg smile head on one side proferring objects) He also found the child's behaviour to change with the mother s behaviour as her economic or social circumstances changed Main [1973] argued that children with unresponsive mothers showed hostility to their mothers in the Ainsworth strange situation procedure as if they failed to disperse tension without their mother s help Prescott [1971] has argued that lack of physical contact should be related to aggression including unprovoked aggression but was unable to locate direct examples for children s behaviour Our findings though unique and thus much in need of replication do not stand in complete isolation

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
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# Evidence That Resident Male Albino Rats Are Not Immune to Attacks by Conspecific Intruders

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Offensive behaviors were exhibited by adult intact and castrated male Sprague Dawley rats introduced into established home-cages of male conspecifics. Implications of this result for Adams [1976] model of intraspecific fighting are presented

Key words rats intraspecific fighting resident intruder paradigm

## INTRODUCTION

"Territoriality commonly is defined with reference to agonistic behavior Territorial animals are ones which occupy and defend an area they repel members of their species by means of attacks and/or displays [Moyer 1968 Wilson 1975] Most species of territory-occupying animals usually are safe from attack by a con specific intruder so long as they remain in their own home region

Rats occupying an area (such as a burrow or laboratory cage) reportedly are safe from attacks by a conspecific intruder Numerous studies demonstrated that male rats defend their home regions from unfamiliar male conspecifics by exhibiting full aggressive posture and biting attack [Adams 1976 Blanchard and

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Blanchard 1977 Calhoun 1962 Lehman and Adams 1977 Luciano and Lor 1975 Price 1978 Telle 1966 Thor and Flannelly 1976] Territory inhabiti rats never were attacked by conspecific intruders [Adams 1976 Thor and Flannelly 1976]

We now report that territory occupying male albino rats are not immune to attacks by conspecific intruders The present investigation originally was desi to determine how frequently resident male albinos attack male castrated and ovariectomized conspecific intruders [after Thor and Flannelly 1976] How we obtained the unpredicted finding that intruders initiated fights with resider rather than vice versa Subsequently a follow up experiment was conducted to examine this unexpected phenomenon more closely

## EXPERIMENT 1

The first experiment was designed as an analysis of agonistic behaviors exh by Sprague Dawley albino rats Essentially the study was a replication of a p vious one dealing with agonistic interactions between Long Evans hooded resi rats and conspecific intruders of different hormonal statuses [Thor and Flanne 1976] Since unselected male albino rats allegedly do not fight very often [Ba 1960 Conner 1972] we attempted to maximize the likelihood of eliciting agonistic behaviors by 1) conducting test sessions during the animals dark phas 2) using the resident intruder paradigm and 3) housing the resident rats in isola tion for several weeks prior to testing

## METHOD

### Subjects

Forty-eight sexually naive rats of the Charles River CD strain purchased fr the Charles River Breeding Laboratories were used Twenty four were inta 12 were castrated males and 12 were ovariectomized females Gonadectomies were performed when the subjects were 30 days of age Like sex pairs of rats we housed in wire mesh cages (18 × 25 × 20 cm) with a reversed 12 hour light-da cycle and food and water available ad libitum

### Procedure

Twelve of the intact males were selected randomly and designated as resi They were transferred to larger wire mesh cages (28 × 28 × 34 cm) at 30 days age and housed individually for 7 weeks prior to the start of the experimer Residents could not see or contact each other The 12 castrated males (gr 12 ovariectomized females (group OVX) and the remaining 12 inta t mal s (group I) were designated as intruders They were maintained individually in mesh cages (18 × 25 × 20 cm) kept in a room separate from that housing res rats

When all subjects were about 120 days old intruders were introduced into residents cages on 3 alternate days Every resident was exposed to three intruders a different one from each intruder group one per day Every intruder was exposed to only one resident Intruder resident pairings were arranged according to a schedule counterbalanced for order A 25 W red incandescent bulb was the sole source of illumination during testing which was conducted several hours after onset of darkness [after Kane and Knutson 1976] All intruders regardless of group were marked identically on their tails This permitted the experimenters to distinguish between residents and intruders while remaining blind to intruders experimental conditions The experimenters used electromechanical counters to record frequencies of the following behaviors exhibited by residents or intruders during the first 20 minutes after intruder introduction 1) sniff anogenital region 2) rub against cage 3) nosing 4) attack (and latency to first attack) 5) full aggressive posture 6) offensive side posture and 7) full submissive posture [Grant and Mackintosh 1963] The observers also recorded the number of ultrasonic vocalizations emitted during resident intruder pairings Rats calls were monitored with an ultrasound detection device (Psyonics Inc Binghamton New York) sensitive to 20–25 kHz frequency range [after Lore Flannelly and Farina 1976 Sales 1972]

Intruders were removed from residents cages 21 hours after introduction Each intruder was asphyxiated with ether shaved and its skin examined for wounds Experimenters recorded the number of small (less than 0 5 cm) medium (between 0 5 and 1 0 cm) and large (greater than 1 0 cm) wounds A wound score was calculated for each intruder [after Luciano and Lore 1975] Intruders stomachs were exposed and examined for ulcers [after Lore and Luciano 1977]

## RESULTS

The behavioral wound score ultrasound and ulcer data were analyzed using analyses of variance The statistical tests revealed a significant difference between residents reactions to groups I C and OVX for only one dependent measure – anogenital sniffs (df = 2 and 22 F = 7 01 P < 0 005) Group OVX intruders were sniffed most frequently ($\bar{X}$ = 16 0) group C intruders were sniffed next most frequently ($\bar{X}$ = 11 9) and group I intruders the least frequently ($\bar{X}$ = 8 8) This result is consistent with that previously reported for Long Evans rats [Thor and Flannelly 1976]

Unexpectedly several intruders exhibited offensive behaviors [ie full aggressive posture and biting attack Grant and Mackintosh 1963] during the 20 minute observation period Attacks by intruders were observed in as many as four pairings three including group I intruders and one including a group-C intruder Full aggressive postures by intruders were seen in as many as ten pairings five including

group I rats and five including group C rats None of the group-OVX intrud s showed attack or full aggressive posture

Investigators who previously used a resident intruder paradigm to study f... by rats reported that intruders never exhibited attack [eg Adams 1976] R... the findings of previous research were that territory-occupying rats 1) initia... fights with conspecific intruders and 2) were immune to attacks by consp... intruders Since the results of Experiment 1 were contrary to those of other ex periments we attempted to replicate and study in greater detail attacks initia... by intruder rats

## EXPERIMENT 2

## METHOD

### Subjects

Sixteen experimentally naive rats of the Charles River CD strain born and r... in the laboratory were used Eight were intact males and eight were intact fem... After weaning at 25 days like sex pairs of rats were housed in wire mesh cages (18 × 25 × 20 cm) with a 14/10 hour light dark cycle and food and water ava able ad libitum

### Procedure

Four of the males were selected randomly and designated as residents Ea... the four males was transferred to a larger wire mesh cage (65 × 25 × 18 cm) a... approximately 1_0 days of age and housed alone for ten days Then two 90-d... old females were introduced into every cage Each set of male and femal s was allowed to cohabit for ten days prior to testing Previous research showed that cohabitation with females promoted agonistic activity exhibited by mal... rats [Flannelly and Lore 1977] All females were removed from colony... two hours daily and kept in holding cages as an attempt to adapt the females... the procedure of removal

The remaining four males were designated as intruders They were ma... individually in wire mesh cages (18 × 25 × 20 cm) kept in a room separate fr... that housing resident rats Intruders were approximately the same age as res...

Intruders were introduced into colony cages on the 11th day after col... formation Females were removed from each cage approximately ten minutes p... to intruder introduction Every resident was exposed to only one intruder a... every intruder was exposed to only one resident Testing for resident intru... agonistic encounters was conducted according to the procedure of Experiment 1 except that no attempt was made to monitor ultrasounds

## RESULTS AND DISCUSSION

The findings of Experiment 1 were confirmed offensive behaviors were exhibited by intruders during the 20-minute observation period Attacks and full aggressive posture by intruders were seen in two pairings The sequence of behaviors exhibited by one of these two pairs was particularly interesting After introduction into the colony cage the intruder began to sniff and ambulate around the cage The resident shortly thereafter approached the intruder and sniffed his anogenital region Cage sniffing by the intruder and anogenital sniffing by the resident continued for a minute or two interspersed with bouts of nosing [contact between the snouts of the two rats Grant and Mackintosh 1963] Subsequently the resident pursued the intruder (while the latter ambulated around the cage) and repeatedly sniffed his anogenital region Pursuit was followed by multiple mounts thrusts and autogrooming of the genitals The resident mounted the intruder numerous times until finally the intruder turned and attacked the resident Not only did the intruder display biting attack and full aggressive posture but the resident exhibited full submissive posture [laying on back with paws up in the air exposing the ventral body surface Grant and Mackintosh 1963] The resident was observed making slow continuous exhalations which previous research showed were correlated with 22 kHz ultrasonic vocalizations [Lore et al 1976] Attacks were initiated by the intruder on 3 occasions during the 20-minute observation period on each occasion attack was preceded by persistent mounting of the intruder by the resident Consequently the resident exhibited full submissive posture as many as nine times in total A similar sequence of behaviors was exhibited by the other resident intruder pairing in which attacks by intruder were seen

The results of the present investigation are contrary to those previously reported by investigators who used a colony intruder paradigm to study fighting by rats The results of previous experiments were that intruders never attacked colony males and that colony males never exhibited full submissive posture [Thor and Flannelly 1976] Moreover Adams [1976] model of intraspecific fighting does not predict offensive behavior by intruders According to that model offensive behavior ordinarily follows the olfactory comparison between a familiar environment and a strange male rat Intruder rats used in both of the present experiments displayed offensive behavior in a situation where the environment was strange Thus presumptive odorant(s) of a familiar environment were not a necessary factor for eliciting attacks by albino rats Adams model probably would be more general in its application if 1) the hypothesized comparison were between a strange male conspecific and an attacker s own odorant and 2) it took into account nonolfactory attack provoking acts such as repeated homosexual mounting

Resident rats used in the present investigation exhibited very low frequency

and intensity of agonistic behavior This finding is consistent with that of ano he study of fighting which used unselected albino rats [Barnett 1960] Evidently there are differences between strains of domestic rat since investigators who experimented with Long Evans hooded rats reported vigorous fighting by th e resident animals [eg Price 1978] There also appear to be differences between *test paradigms since investigators who studied attack behaviors of mal members* of mixed sex albino-rat colonies reported vigorous fighting by their homecage animals [eg Blanchard and Blanchard 1977] Parametric experiments designed to assess the importance of strain and test paradigm as factors affecting offe sn interactions would be very helpful for identifying the independent variables rel to onset of attack

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AGGRESSIVE BEHAVIOR
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# Adrenal Mediation of Intermale Aggression Maintained by Aromatized and Reduced Metabolites of Testosterone

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Individually housed CD-1 mice were either sham castrated or castrated and treated with testosterone (T) estradiol benzoate (EB) dihydrotestosterone (DHT) a combination of EB and DHT (EB+DHT) or the injection vehicle Following 16 days of isolation and subcutaneous injections, animals were tested repeatedly for fighting behavior in paired encounters with nonaggressive stimulus males. Results indicated that the T and EB+DHT groups fought to the same extent as the gonadally intact group Both the EB and DHT groups fought more than the vehicle-treated group but less than the T EB+DHT and sham castrated groups. A similar study was subsequently performed with adrenalectomized animsls. Adrenalectomy eliminated agonistic responses in animals receiving metabolites of testosterone (EB DHT EB+DHT) but had only slight effects in gonadally intact and T-treated castrated mice The results suggested that a) EB and DHT either singly or in combination maintain aggression through a synergism with adrenal steroids b) the combined effects of EB and DHT reflect an additive action rather than synergistic interaction notwithstanding the synergism with adrenal steroids c) metabolism of testosterone to estrogen and dihydrotestosterone does not sufficiently account for the action of testosterone

Key words testosterone estradiol dihydrotestosterone adrenals, aggression isolation

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## INTRODUCTION

Simple endocrine manipulations such as castration and testosterone replacement have established androgen-dependencies for intermale aggression in mice and male copulatory behavior in rats In a series of remarkably parallel studies of sexual and aggressive behavior compelling evidence has been gathered to suggest that the maintenance of these responses is also dependent upon the active metabolism of testosterone by neural tissue

It is evident that testosterone metabolism occurs in the brain Following the in vivo administration of $^3$H testosterone the bulk of radioactivity in rat brain cell nuclei consists of three components estradiol 17β formed by aromatizing enzymes in the brain dihydrotestosterone formed by reducing enzymes in the brain and unmetabolized testosterone [Lieberburg and McEwen 1977] Similar metabolic processes occur in brains of other species including the mouse [Naftolin and Ryan 1975] Moreover both the rat and mouse possess a specific brain receptor for estrogens and an androgen receptor which binds dihydrotestosterone and testosterone [Attardi and Ohno 1976] Behavioral evidence is consistent with the hypothesis that testosterone metabolites mediate testosterone action Exogenous combinations of estradiol and dihydrotestosterone maintain sexual behavior in the castrated rat [Baum and Vreeburg 1973 Larsson Södersten and Beyer 1973] and intermale aggression in the castrated mouse [Brain and Poole 1976 Finney and Erpino 1976] Although most of the data suggest that estradiol and dihydrotestosterone interact synergistically to maintain sexual behavior some studies indicate that estradiol alone is at least as effective as testosterone in maintaining fighting [Bowden and Brain 1978 Brain and Bowden 1978 Brain and Poole 1976] The results of treatment with estrogen antagonists and aromatization inhibitors further support the idea that testosterone action is dependent upon aromatization CI 628 a synthetic anti-estrogen which blocks tissue uptake of $^3$H-estradiol and inhibits estradiol induced lordosis behavior [Whalen and Gorzalka 1973] also impairs testosterone maintained copulatory behavior in male rats [Luttge 1975] Another anti-estrogen MER 25 suppresses androgen maintained fighting in male mice [Brain Benton Goldsmith and Bowden 1976] Steroidal inhibitors of aromatization block testosterone in[illegible] mounting behavior [Christensen and Clemens 1975] and intermale aggression [Bowden and Brain 1978] however they fail to suppress estradiol induced behavior and thus appear to have a relatively specific mode of action

Although substantial evidence supports the speculation that aromatization mediates the effects of testosterone there is some question as to whether this sufficiently accounts for the observed data Adrenalectomy eliminates ejaculation in castrated rats maintained with either high doses of estradiol [Gorzalka Rezek and Whalen 1975] or low doses of estradiol in combination with dihydrotestosterone [Gorzalka and Roach 1978] In contrast adrenalectomy fails to re[illegible]

copulatory activity in testosterone treated castrates Since estradiol treatment often increases adrenal secretion rate [eg Colby and Kitay 1976] and produces considerable adrenal hypertrophy and hyperplasia when combined with dihydro testosterone [Gorzalka and Roach 1978] adrenal steroids such as androgens estrogens or glucocorticoids may act in concert with exogenous estradiol and dihydrotestosterone to maintain copulatory behavior Thus the ability of estradiol and dihydrotestosterone to maintain ejaculations can be interpreted as evidence for aromatization adrenal stimulation or both The present study examined the relative effectiveness of androgens and estrogen in maintaining intermale aggression in castrated and adrenalectomized castrated mice

## EXPERIMENT 1

Both testosterone and a combination of estradiol and dihydrotestosterone can restore fighting in castrated mice [Brain and Poole 1976 Finney and Erpino 1976] However there is some question as to whether estradiol alone restores agonistic behavior or whether dihydrotestosterone synergistically facilitates the action of estradiol In castrates of the Tuck TO strain normal levels of fighting are maintained with either 25 μg testosterone (T) 1 μg EB estradiol benzoate (EB) or a combination of 500 μg dihydrotestosterone (DHT) and 1 μg EB [Bowden and Brain 1978 Brain and Poole 1976] Treatment with EB in the absence of DHT also restores fighting in castrated Swiss Webster mice [Edwards and Burge 1971] In contrast even massive doses of EB fail to appreciably restore aggression in castrated CD 1 mice [Luttge 1972] In the latter strain restoration of preoperative levels of aggression apparently requires either 500 μg T or a com bination of 2-4 μg EB and 200 μg DHT [Finney and Erpino 1976] These diverse results likely reflect differences in techniques for generating intermale aggression as well as strain differences in sensitivity to steroids analogous to those previously reported for sexual behavior in mice [Gorzalka and Whalen 1974 1976] The present study attempted to confirm that EB and DHT act synergistically to main tain intermale aggression in CD 1 mice

## METHODS

CD 1 male were obtained from Canadian Breeding Farms Montreal Canada and were housed in groups of six per cage with food and water available ad libitum Animal colonies were maintained at 21 C on a 12/12 hour light/dark cycle with lights on at 2200 hours At the age of 60 days animals were either castrated (N=60) or sham castrated (N=12) while under light ether anesthesia Mice were individually housed in 11 (height) × 28 × 16 cm polypropylene cages immediately after surgery These were equipped with straight wire tops each of which con tained a built in feeder and water dispenser which together displaced 452 cc At

the age of 64 days daily subcutaneous hormone injections were started Cas received either 500 µg T (N=12) 4 µg EB (N=12) 200 µg DHT (N=12) 4 µg combined with 200 µg DHT (N=12) or the oil vehicle 0 05 ml of peanut oil Sham castrates received the oil vehicle

Behavioral tests were conducted on the 16th 18th and 20th injection da Stimulus CD-1 males which had been housed 6 per cage served as opponents test bouts Test sessions were conducted between 1300 and 1600 hours in Pl xiglas enclosures measuring 22 (height) X 12 X 23 cm Tests were con in neutral enclosures rather than home cages to permit comparison with the of Finney and Erpino [1976] Each experimental male was adapted to th e closure for 5 minutes presented with a stimulus male and observed for 10 r Experimental stimulus male pairings were randomized for successive tests D observation periods the latency to attack and the frequency and duration of attacks against stimulus males were scored via an Esterline Angus event r This permitted statistical analysis of the following measures percentage of animals that fought at least once percentage of trials in which fights occur mean number of attacks per trial mean cumulative attack duration per trial mean attack duration per attack (calculated by dividing cumulative atta k d by number of attacks for each animal) and the mean latency to attack A which failed to attack were assigned a latency of 600 seconds

## RESULTS

As shown in Figure 1 treatment with either T or a combination of EB a DHT (EB+DHT) maintained intermale aggression at levels comparable to th exhibited by intact animals Treatment with either EB alone or DHT alo ap peared more effective than vehi le treatment Fisher exact probability tes [Siegel 1956] indicated that there were no significant differences between th T EB+DHT and inta t groups on the percentage of trials with attacks All th groups differed significantly from the EB group ($P < 0\ 001$) DHT ($< 0\ 001$) vehicle group ($P < 0\ 001$) on the percentage of trials with attacks Wh th vehicle group exhibited less trials with attacks than the DHT ($P = 0\ 003$) a groups ($P = 0\ 010$) the two steroid groups did not differ from each othe Th were no signifi ant differences between the T EB+DHT and inta t g m percentage of animals fighting at least once Intact animals and T treated ca were more likely to fight than either EB treated ($P = 0\ 007$) or vehicl t castrates ($P < 0\ 001$) but not DHT treated castrates The EB+DHT g o differed from the EB-treated ($P = 0\ 033$) and vehicle treated group ($P < 0\ 0$ but not the DHT group DHT treatment was significantly different from v treatm nt ($P = 0\ 006$) although the percentage of EB treated animals atta ked did not differ from that of either DHT treated or vehi le treated an mals

*Table I suggests that omparable differences occurred in the number of a per trial cumulative atta k duration per trial and attack laten y An a lys*

variance revealed significant differences in the mean number of attacks ($P < 0.01$). Group comparisons were made using a posteriori Newman Keuls tests at the 1% probability level. This indicated two homogeneous subsets one consisting of the T, EB+DHT, DHT and intact groups and the other consisting of the vehicle, EB

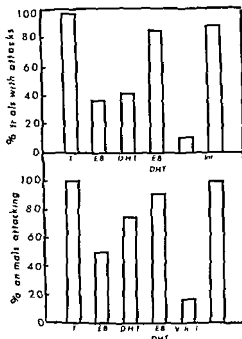



Fig. 1 Effects of steroid hormone treatment on the percentage of CD-1 mice attacking at least once in three successive tests and on the percentage of trials with attacks. Animals were castrated and treated daily with T (N=12), EB(N=12), DHT(N=12), EB+DHT(N=12) or the oil vehicle (N=12) or had intact gonads and were vehicle treated(N=12)

TABLE I Effects of Steroid Hormone Treatment on Intermale Aggression in Castrated CD-1 Mice*

| Treatment | N | Mean number of attacks per trial | Mean cumulative attack duration (sec) per trial | Mean attack duration (sec) per attack | Mean attack latency (sec) per trial |
|---|---|---|---|---|---|
| T | 12 | 9.1 ± 1.4 | 31.0 ± 4.5 | 3.6 ± 0.3 | 120.3 ± 43.8 |
| DHT | 12 | 3.9 ± 0.9 | 13.8 ± 3.3 | 3.4 ± 0.8 | 426.9 ± 93.0 |
| EB | 12 | 2.8 ± 1.6 | 9.9 ± 3.8 | 3.8 ± 0.7 | 406.8 ± 61.8 |
| EB + DHT | 12 | 8.2 ± 1.3 | 24.0 ± 3.3 | 3.2 ± 0.4 | 219.6 ± 68.3 |
| Vehicle | 12 | 1.7 ± 0.7 | 4.4 ± 1.3 | 2.9 ± 0.5 | 542.1 ± 18.4 |
| Intact gonads | 12 | 7.0 ± 1.1 | 23.0 ± 2.7 | 3.9 ± 0.5 | 191.4 ± 71.7 |

*Results are based on the mean (± standard error) of three successive tests

and DHT groups An analysis of variance and Newman Keuls comparisons rev an identical pattern of significant treatment differences in the mean cumulati attack duration per trial However there were no significant differences in the mean duration of attacks An analysis of variance indicated that there were si ficant differences in mean attack latency ($P < 0.01$) Newman Keuls comparis revealed two homogeneous subsets one consisting of the T EB+DHT EB DH and intact groups and the other consisting of the EB DHT and vehicle grou

## EXPERIMENT 2

The results of Experiment 1 confirmed that combined treatment with EB a DHT mimics T in maintaining preoperative levels of agonistic behavior in the CD 1 mouse It remains to be determined whether the combined action of th testosterone metabolites was mediated by adrenal stimulation If adrenalector were shown to differentially influence T treated and EB and DHT treated ani this would suggest that aromatization of T to E and reduction of T to DHT d not sufficiently account for testosterone action This design rests on the assum tion that adrenalectomy per se would not suppress intermale aggression in intu mice The literature is controversial on this issue although at worst fighting is merely reduced and not abolished by adrenalectomy [Brain Nowell and Wo 1971 Harding and Leshner 1972] Some investigators contend that adrenalec has no effect [Burge and Edwards 1971 Welch 1968 Yen Day and Sigg 19 It has been suggested that adrenalectomy does not produce a lasting suppressi but prolongs the isolation interval required for the development of intermale aggression [Sigg Day and Colombo 1966] Because of this suggestion th p experiment employed previously isolated and experienced animals The effect adrenalectomy on intact mice and steroid treated castrated mice were exami

## METHODS

On the day following the last behavioral test in Experiment 1 all experime animals were bilaterally adrenalectomized while under light ether anesthesia Body and adrenal weights were recorded Adrenalectomized mice were subse quently maintained on 0 9% saline Daily injection schedules identi al to th Experiment 1 were continued Similar behavioral tests were conducted on the 1 14th and 16th postadrenalectomy days In order to minimize the influen e of nonspecific debilitation behavioral data were excluded from analysis if animals failed to survive to the 37th postadrenalectomy day

## RESULTS

As shown in Figure 2 only T treated castrates and gonadally intact mice con tinued to fight after adrenalectomy Although the EB+DHT group was initially

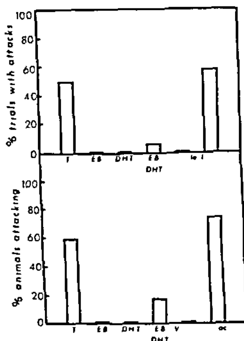



Fig ? Effects of steroid hormon treatment on the percentage of adrenal ct mized CD 1 mice attackin at least once in three successive tests and on the percenta e of trials with atta ks Animals were castrated and treated daily with T(N 10) EB(N=7) DHT(N 6) EB+DHT(N 6) or the oil vehicle(N=8) or had intact gonads and were vehicle treated(N 8)

to the T and intact groups prior to adrenalectomy all but one animal in the group failed to fight after adrenalectomy That animal fought on one trial only Fisher exact probability tests indicated that there were no significant differences in the percentage of trials with attacks between either the gonadally intact and T groups or the EB+DHT EB DHT and vehicle groups Both the gonadally intact and T group animals fought on more trials than the EB+DHT ($P < 0.001$) EB ($P < 0.001$) DHT ($P < 0.001$) and vehicle groups ($P < 0.001$) There were no significant differences in the percentage of animals fighting at least once between either the intact and T groups or the EB+DHT EB DHT and vehicle groups Intact animals were more likely to fight than EB+DHT ($P = 0.048$) EB ($P = 0.006$) DHT ($P = 0.009$) and vehicle treated animals ($P = 0.003$) T treated animals were more likely to fight than EB ($P = 0.017$) DHT ($P = 0.026$) and vehicle treated animals ($P = 0.011$)

Table II reveals essentially the same pattern gonadally intact and T treated animals fought others did not Since agonistic responses were frequently absent nonparametric tests were used to analyze the data in Table II On three of the measures number of attacks per trial mean cumulative attack duration per trial

**TABLE II** Effects of Steroid Hormone Treatment on Intermale Aggression in Adrenalectomized Castrated CD 1 Mice*

| Treatment | N | Mean number of attacks per trial | Mean cumulative attack duration (sec) per trial | Mean attack duration (sec) per attack | Mean attack latency (sec) per trial |
|---|---|---|---|---|---|
| T | 10 | 4 9 ± 1 3 | 16 5 ± 3 4 | 2 9 ± 2 1 | 780 4 ± 94 9 |
| DHT | 6 | 0 | 0 | 0 | 600 0 ± 0 |
| EB | 7 | 0 | 0 | 0 | 600 0 ± 0 |
| EB + DHT | 6 | 0 7 ± 0 7 | 1 8 ± 1 8 | 2 5 ± 0 | 560 5 ± 39 5 |
| Vehicle | 8 | 0 | 0 | 0 | 600 0 ± 0 |
| Intact Gonads | 8 | 4 8 ± 1 1 | 12 6 ± 3 5 | 2 7 ± 1 1 | 344 3 ± [illegible] |

*Results are based on the mean (± standard error) of three successive tests

and mean attack latency statistical differences between groups were identical Mann Whitney U tests [Siegel 1956] indicated that T was more effective than EB+DHT (P < 0 05) EB (P < 0 05) DHT (P < 0 05) and the vehicle (P < 0 05) On the same measures gonadally intact mice were superior to castrates treated with EB+DHT (P = 0 015) EB (P = 0 007) DHT (P = 0 010) and the vehicle (P = 0 005) There were no significant differences between either T treated castrates and intact mice or EB+DHT EB DHT and vehicle treated castrates The fourth measure in Table I mean duration of attacks was not statistically analyzed since the number of attacks was commonly zero

It is apparent that postadrenalectomy scores were lower than preadrenalectomy scores This is best illustrated by comparing the percentage of trials in which fights occurred in the present experiment with the percentages of the corresponding animals in Experiment I McNemar tests for the significance of changes [Siegel 1956] revealed postoperative reductions in castrates receiving T (P < 0 001) EB+DHT (P < 0 001 EB (P < 0 025) DHT (P < 0 01) and gonadally intact mice (P < 0 025)

An analysis of variance of adrenal weights revealed no significant differences However there was a trend toward differences between the intact group and each of the castrate groups Mean adrenal weights (mg) and standard errors were as follows T 5 3 ± 1 [illegible] EB+DHT 5 5 ± 1 4 EB 5 2 ± 0 8 DHT 5 5 ± 1 0 vehicle 5 0 ± 0 9 intact 3 6 ± 0 4 Adrenal/body weight ratios presented essentially the same patterns since there were no significant body weight differences

## DISCUSSION

The failure of EB+DHT to maintain intermale aggression in adrenalectomized mice implies that aromatization and reduction while perhaps necessary are not sufficient to account for testosterone action There are several lines of evidence

which would even challenge the necessity for aromatization Treatment with dihydrotestosterone a nonaromatizable androgen occasionally restores aggression in castrates of some strains [Bowden and Brain 1976 Brain and Poole 1975 Luttge and Hall 1973] Although previous attempts have failed to find significant effects of dihydrotestosterone in CD 1 mice [Finney and Erpino 1976 Luttge 1972] the steroid clearly facilitated aggression in Experiment 1 Apparently this is the first successful demonstration that a nonaromatizable androgen potentiated fighting in CD-1 mice

Also contrary to the aromatization hypothesis there is a significant negative correlation between agonistic behavior and the activity of aromatizing enzymes in mouse brain cell nuclei [Dessi Fulgheri Lucarini and Lupo de Prisco 1976] This finding is puzzling in relation to evidence that an aromatization inhibitor blocks T induced fighting [Bowden and Brain 1978] There are other inconsisten cies in the evidence supporting the aromatization hypothesis For example the anti-estrogen MER 25 inhibits androgen induced aggression in mice [Brain et al 1976] and facilitates androgen induced mounting in rats [Baum and Vreeburg 1976] MER 25 has a mild affinity for estrogen receptors in the mouse and rat brain [Attardi and Ohno 1976] Baum and Vreeburg [1976] have suggested that since MER 25 and estradiol both have an affinity for brain estrogen receptors and estradiol is normally involved in the control of mounting behavior MER 25 may facilitate mounting by activating these binding sites If this explanation were correct it would suggest that either MER 25 must have a different mechanism of action in the mouse or the action of MER 25 in the mouse is evidence against the aromatization hypothesis Perhaps the terms aromatization inhibitor and anti estrogen impart a generous degree of specificity to the drugs they describe

Aside from the issue of aromatization there is also reason to doubt Finney and Erpino s [1976] conclusion that EB and DHT interact synergistically Figure 1 and Table I indicate that EB and DHT were individually capable of facilitating aggression to a significant extent and therefore may have simply acted in an additive manner when combined Thus it is conceivable that an increased dose of either steroid would mimic the effect of T Experiment 2 suggests that the effec tiveness of EB and DHT whether they act synergistically or additively is dependent on the adrenals Similarly when DHT or EB are administered individually potency is enhanced by the presence of the adrenals If a synergism exists it may be be tween EB and adrenal steroids and DHT and adrenal steroids

The present results provide further evidence for remarkable similarities in steroidal regulation of intermale aggression in mice and copulatory behavior in male rats Previous work showed that both behaviors could be activated by either testosterone estradiol or a combination of estradiol and dihydrotestosterone It now appears that unlike testosterone estradiol or estradiol combined with dihydrotestosterone acts in concert with adrenal steroids to maintain behavior A variety of treatments purported to facilitate copulatory activity by a direct

action on the brain may be adrenally mediated [eg Gorzalka et al 1975 Gorz[illegible] and Roach 1978 Paris Resko and Goy 1971 Whalen Neubauer and Gorzalka 1975] The same may hold true for intermale aggression

There are some indications of qualitative differences in the steroidal regulation of these behaviors Adrenalectomy per se often produces no significant effect on the copulatory behavior of gonadally intact rats and mice [Bloch and Davidson 1968 Wallis and Luttge 1975] In group-housed mice adrenalectomy may even facilitate mating activity [Gorzalka and deCatanzaro 1979] However according to some previous reports [eg Brain et al 1971 Harding and Leshner 1977] and the present study intermale aggression in intact mice is somewhat reduced by adrenalectomy This is not to infer that adrenal hormones necessarily have a permissive action in gonadally intact mice Brain et al [1971] have suggested that the elevated levels of ACTH which follow adrenalectomy rather than the withdrawal of adrenal hormones may directly suppress aggression

Another apparent difference is seen in dihydrotestosterone effectiveness This *nonaromatizable androgen restores intermale aggression to at least some extent in* castrated mice [Brain and Bowden 1978 Brain and Poole 1976 Luttge and Hall 1973 Experiment 1] However dihydrotestosterone has little or no effect in restoring copulatory behavior in castrated rats [Baum and Vreeburg 1973 Larsson et al 1973] This could merely reflect a peculiarity of the rat rather than a major endocrine difference between mating and aggression In castrated rabbits guinea pigs mice hamsters and rhesus monkeys [Ågmo and Sodersten 1975 Alsum and Goy 1974 Luttge and Hall 1973 Phoenix 1974 Whalen and DeBold 1974] nonaromatizable androgens such as dihydrotestosterone partially or completely restore mating activity

## ACKNOWLEDGMENTS

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# Canine Responses to Familiar and Unfamiliar Humans

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Dogs were observed during controlled approaches by their owners and by strangers. Significant differences between the dogs responses to their owners and their responses to strangers were found These results supported the popular belief that dogs respond differently to different persons and not merely to different situations in which persons are usually encountered

Key words canids communication defense sociality

## INTRODUCTION

The literature on dog human relationships has long assumed that domestic dogs behave differently toward familiar and unfamiliar human beings To familiar humans they are thou ht to direct affiliative behavior patterns to unfamiliar humans patterns of aggression or defense The phenomenon is interesting be cause it represents the transfer during the course of domestication of aggressive and affiliative patterns from an intra to an interspecific context [Fox 1968 1971 Fuller and Dubois 1962 Lorenz 1952 Schenkel 1967 Scott 1958 1967 Scott and Fuller 1965]

While often described in anecdotes this difference in the behavior of dogs toward familiar and unfamiliar humans has never been evoked under controlled conditions Consequently the difference might as reasonably be attributed to the different circumstances under which dogs usually encounter familiar and un

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familiar people as to the difference in familiarity The experiment reported h was designed to discover if the response difference is still observed when dogs a approached under standardized conditions

## METHOD

The method was based on John [1973] Dogs were approached in a stand manner while they were chained in their owners yards Each dog was approa once by his owner and once by an unfamiliar experimenter The do s behav during the approaches was filmed and tape recorded

### Subjects

The subjects were 20 dogs 10 males and 10 females kept as pets in the ci of Worcester Massachusetts Subjects ranged in age from nine months to sev years A variety of moderately large to large breeds were used all with erect e

### Procedures and Equipment

During the setting up of the experiment the dog was confined out of s ht the house or kennel The experimenter s car was parked on the edge of the ya in the best spot for filming and recording and the camera and microphone we positioned inside the car The camera used was a Beaulieu 8000S Super 8 a d recording equipment consisted of a Panasonic microphone attached to a Paras RQ-4135 cassette tape recorder

The procedure called for the stimulus persons to approach the chained d e walking along the edge of the roadway to a point abreast of the dog and th n turning to walk directly into the yard to a point 16 feet short of the dog The positioning of the dog and the size of the approach course were varied with th size of the property to keep the proportions as constant as possible The m al screw type dog stake to which the dog would be chained was placed from 35 t 50 feet from the edge of the yard The three stakes which marked the appr course were placed as follows Beginning at the dog stake the experimenter walked on a line perpendicular to the street Stake No 3 was placed al th s line 16 feet from the dog stake and stake No 2 was placed where the l e ters the edge of the street Stake No 1 was placed along the edge of the yard a mately where a person walking along the edge of the roadway would first be noticed by the dog

The dog was then brought out and attached to the stake by a 10 foot s el chain The owner and the stranger were hidden down the street from sta in a spot out of sight of the dog stake but within sight of the experime er scr When the dog had bec me acclimated to the situation the cameraman s nal

the first approach When the dog had stopped reacting to the first approach and re sumed his preapproach behavior the cameraman signaled the second approach The order of the approaches – owner first or stranger first – was alternated from dog to dog

The approach was regulated by tape recorded instructions played to the ap proacher through earphones from a cassette tape recorder which the approacher carried over his or her shoulder Each approach consisted of six movements During the first movement the approacher walked from his hiding place to stake No 1 and then along the edge of the yard to stake No 2 At stake No 2 he stopped turned to face the dog and said Good dog in a neutral tone of voice During the second movement the approacher walked from stake No 2 to stake No 3 stopped repeated Good dog and waited without moving for approximately ten seconds During the third movement the approacher raised his arm rapidly over his head took a step forward as if to strike the dog then immediately re turned to his previous stance and position and waited for another ten seconds During the fourth movement the approacher knelt saying Good dog and extended one hand forward palm up and open as if to feed the dog He then returned to his previous stance and position and waited without moving for about seven seconds During the fifth movement the approacher turned to face stake No 2 He remained standing thus with his back to the dog for about ten seconds and then walked to stake No 2 During the sixth movement the approacher passed stake No 1 and walked along the edge of the yard past stake No 1 to the spot where he had started

## Data Analysis

The film record was analyzed using an Angus Dual Eight 2808 editor viewer Forty two behavior categories were scored for each eight frames (one second) of each movement of the approach Many of the original categories produced data which were either unreliable unaffected by experimental procedures or too low in frequency to warrant discussion On the frequencies of each of the remaining 19 behavior categories three analyses of variance were performed to determine 1) if the frequency of occurrence differed during the various movements of the owner approach and during the various movements of the stranger approach 2) if the frequency of occurrence over all movements of the stranger approach was dif ferent from the frequency of occurrence over all movements of the owner approach and 3) if the pattern of response to the stages of approach differed between the owner approach and the stranger approach Details of category definitions reliability figures and variance analyses may be found in Rappolt [1976] a copy of which may be ob tained by writing the authors

BLE I Croup Means

| avior egory | Far ap proach speak | Near ap proach speak | Arm raise | Kneel speak | Back to dog | Exit | Mean | Far ap proach speak | Near ap proach speak | Arm raise | Kneel speak | Back to dog | Exit | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean proportion of time X 100 | | | | | | | | | | | | | |
| | Owner approach | | | | | | | Stranger approach | | | | | | |
| sition | | | | | | | | | | | | | | |
| orward | 5 | 71 | 54 | 60 | 60 | 46 | 57 | 51 | 56 | 56 | 49 | 40 | 36 | 48 |
| ntermediate | 7 | 15 | 6 | 0 | 22 | 28 | 23 | 21 | 11 | 19 | 22 | 24 | 26 | 21 |
| ack | 06 | 06 | 06 | 08 | 08 | 06 | 07 | 12 | 13 | 14 | 16 | 15 | 16 | 14 |
| otion direction | | | | | | | | | | | | | | |
| o motion | 76 | 67 | 74 | 63 | 81 | 75 | 73 | 70 | 65 | 70 | 66 | 70 | 70 | 69 |
| loves toward | 14 | 15 | 04 | 10 | 05 | 08 | 09 | 12 | 17 | 05 | 08 | 04 | 06 | 09 |
| loves away | 04 | 08 | 13 | 17 | 11 | 00 | 09 | 06 | 08 | 16 | 17 | 12 | 08 | 11 |
| orizontal gaze direction | | | | | | | | | | | | | | |
| ooks toward | 67 | 65 | 49 | 60 | 58 | 62 | 60 | 58 | 49 | 43 | 37 | 31 | 39 | 43 |
| ooks almost toward | 2 | 25 | 21 | 17 | 19 | 21 | 21 | 22 | 19 | 19 | 23 | 21 | 21 | 21 |
| ooks to side | 10 | 07 | 19 | 16 | 09 | 08 | 12 | 11 | 15 | 21 | 22 | 18 | 21 | 18 |
| ooks away | 0[illegible] | 01 | 07 | 08 | 12 | 07 | 06 | 07 | 15 | 16 | 16 | 23 | 12 | 15 |
| il position | | | | | | | | | | | | | | |
| p | 3[illegible] | 2 | 16 | 16 | 14 | 28 | 23 | 25 | 26 | 19 | 25 | 27 | 29 | 25 |
| Down | 55 | 7 | 79 | 78 | 80 | 67 | 72 | 69 | 63 | 70 | 64 | 57 | 55 | 63 |
| il motion | | | | | | | | | | | | | | |
| Moving | 14 | 49 | 4[illegible] | 33 | 16 | 11 | 28 | 02 | 21 | 19 | 16 | 08 | 05 | 12 |
| Still | 80 | 47 | 57 | 54 | 78 | 84 | 67 | 92 | 68 | 70 | 73 | 81 | 84 | 78 |
| ars | | | | | | | | | | | | | | |
| Forward | 48 | 30 | [illegible] | [illegible]4 | 44 | 46 | 37 | [illegible]3 | 35 | 41 | 37 | 47 | 52 | 46 |
| Up | 3[illegible] | 35 | 3[illegible] | 34 | 3[illegible] | 38 | 3[illegible] | [illegible]4 | 38 | 32 | 35 | 3[illegible] | 32 | 33 |
| Down | 11 | 14 | 3 | 1 | 08 | 1[illegible] | 15 | 05 | 07 | 09 | 08 | 02 | 05 | 0[illegible] |
| [illegible] | 0[illegible] | 0 | 11 | 1 | 05 | 0[illegible] | 11 | 04 | 17 | [illegible] | 17 | 08 | 04 | 12 |
| [illegible] | [illegible] | 08 | 04 | [illegible] | 01 | 0 | 03 | 03 | 1[illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |

TABLE II Significance Levels Analyses of Variance

| Behavior category | Between movements within each approach: Owner approach | Between movements within each approach: Stranger approach | Between owner and stranger approaches: Approach totals | Between owner and stranger approaches: Patterns of response over stages of approach |
|---|---|---|---|---|
| Position | | | | |
| Forward | – | – | P < 0.10 | – |
| Intermediate | – | – | – | – |
| Back | – | – | – | – |
| Motion direction | | | | |
| No motion | – | – | – | – |
| Moves toward | P < 0.05 | P < 0.01 | – | – |
| Moves away | | P < 0.10 | – | – |
| Horizontal gaze direction | | | | |
| Looks toward | – | P < 0.01 | P < 0.01 | – |
| Looks almost toward | – | – | – | – |
| Looks to side | P < 0.05 | – | P < 0.05 | – |
| Looks away | P < 0.10 | P < 0.10 | P < 0.01 | – |
| Tail position | | | | |
| Up | P < 0.01 | – | – | P < 0.10 |
| Down | P < 0.05 | – | – | P < 0.01 |
| Tail motion | | | | |
| Moving | P < 0.01 | P < 0.01 | P < 0.01 | P < 0.05 |
| Still | P < 0.01 | P < 0.01 | P < 0.10 | – |
| Ears | | | | |
| Forward | P < 0.01 | P < 0.01 | – | – |
| Up | – | – | – | – |
| Down | | – | P < 0.10 | – |
| Back | P < 0.01 | P < 0.01 | – | – |
| Bark rate | – | P < 0.01 | P < 0.05 | P < 0.01 |

## RESULTS

The most frequent response of the dogs during the procedures of the experiment was to stand motionless and silent, with head up and tail down and still orienting in the direction of the approacher. Frequent alternative patterns included tail wagging and raising, barking, averting the gaze, and alternately coming toward and rushing back from the approacher.

Some behavior patterns were clearly more common during the close movements of the approach than during the distant movements, others less common. Tail wagging, putting the ears back, looking away, lowering the tail (owner approach) and barking (stranger approach) were all more frequently observed when the

approacher was within the boundaries of the yard (movements 2–5) than wh he was outside the boundaries (movements 1 and 6) Holding the tail still p t the ears forward and holding the tail up (owner approach) were all more freq when the approacher was outside the boundaries

Some systematic differences were observed in the patterns of respons of d to their owners and to strangers The dogs gazed at their owners more than at strangers particularly in the early phases of the approaches They spent mo time close to their owners wagged their tails more for their owners and ba k at them less Although the overall frequency of tail raising was comparabl in t two approaches the temporal course of this response differed During th stra approach the frequency of tail raising remained at a stable moderate level During the owner approach however the response was more frequent when th owner was at a distance and less frequent when the owner was near

A surprising feature of the dogs response to the stranger approach was th combination of barking and tail wagging Both responses occurred more freq during the closest movements of the stranger approach than during the dista t movements Direct study of the film record showed that dogs often barked a wagged their tails at the same time A correlation coefficient computed across dogs shows that those dogs which barked at the strangers most were also th d which wagged their tails most ( r = 0 569 P < 0 01)

## DISCUSSION

The results lend some support to the idea that dogs differ in their respons t familiar and unfamiliar humans The owner approached dogs by moving tow the approacher lowering and wagging their tails and retracting their ears con formed to the pattern of active submission which several authorities agree characterizes the response of dogs to dominant familiar conspecifics [Schenk 1967 describes the pattern most clearly] The stranger approached dogs beha more ambiguously In some respects their response seemed a less vi oro s form of active submission They too tail wagged approached and ear retracted t s degree But in at least two respects their response seemed a different kind of pattern When the stranger was close the dogs did not lower their tails and th did bark Barking has been characterized as belonging to a pattern of d fen threat [Scott and Fuller 1965] If this characterization is appropriate then th dogs in our study were simultaneously giving out appeasing and defensive com munications toward the stranger

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# The Development of Territorial-Induced Intermale Agonistic Behavior in Albino Laboratory Mice

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Male mice of the CF 1 strain (Mus musculus) were allowed to take up lone residence in a small territory consisting of a 60-cm enclosure attached by a tubular runway to a standard mouse cage with food water and bedding A group of ten mice each of which resided in its own separate enclosure for 24 hours were more aggressive toward intruders than other groups of ten mice following six hour residence periods, or no such residence Aggression toward intruders increased in repeated weekly tests of the six hour residents but after four weeks of testing did not reach the maximum stable level displayed by the 24 hour residents over four weeks of testing In another experiment the 24-hour residence period of groups of 20 CF 1 male mice was disturbed by briefly removing the mouse from the enclosure before introducing the intruder at various intervals prior to testing Removal of the resident five minutes before testing resulted in a marked decrease in aggression toward intruders Although lesser decreases in aggression followed intervals of 30 45 and 60 minutes a 180 minute interval resulted in no appreciable effects compared to undisturbed controls It is concluded that exposure to the stimuli provided by the enclosure results in an aggressive readiness in the resident mouse which reaches a high level within a 24 hour period

Key words aggression mice territorial behavior enclosure residence period intruder

## INTRODUCTION

Male mice are known to form territories in large [Anderson and Hill 1965 Reimer and Petras 1967] and in small complex enclosures [Crowcroft 1966 Mackintosh 1970 Poole and Morgan 1976] In either case the dominant

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male emerging as a territory holder patrols the territory and attacks intruders which cross its boundaries. It has been noted that this behavior should not be interpreted as defense of the territory [see Moyer, 1972]. However, the cues provided by a small complex enclosure result in a characteristic behavior pattern of intermale aggression in which the residing animal has a decided advantage. The work of Mackintosh [1973] has demonstrated that the cues in the enclosure which delimit the territory of a particular male mouse are primarily visual.

Although a number of variables have been investigated which appear to be necessary for this sort of agonistic behavior, the use of complex enclosures housing several male mice has made it difficult to conduct controlled studies of the behavior itself. A complicated enclosure is not necessary to stimulate high levels of aggression in resident males which is characteristic of the agonistic behavior of territorial males observed in prior studies. Rather than permitting the resident males to determine a territory, each mouse can be placed in an enclosure which is small enough to insure that the resident animal will control the entire area [Thurmond, 1975]. Mackintosh [1970] has observed that the behavior of dominant males in control of an entire area shows many of the characteristics of a territory holder in the presence of other males who also hold territories.

The results of prior work [Thurmond, 1975] indicated that 90% of resident males attacked and dominated an intruder if the period of residence before testing was at least 24 hours, provided the test for aggression occurred during the active (dark) phase of the animal's diurnal cycle. It had also been observed that although the occurrence of the resident male's agonistic behavior was highly reliable following this period, it also appeared to be vulnerable to disruption during the hour or so just preceding the test. One aim of the present experiments was to investigate the effect of reducing the time spent by the resident in the enclosure before introducing the intruder. The effects of repeating this procedure at intervals of one week for a total of four weeks were also examined. Second, we investigated the degree to which the resident male's agonistic behavior was susceptible to disruption prior to the test for aggression.

## MATERIALS AND METHODS

### Subjects

Ninety-day-old male mice (Mus musculus) of the CF-1 strain (Carworth Farms, Wilmington, Massachusetts) were used in the experiments. The mice were housed five per cage on sawdust bedding with Purina Rat Mouse Chow and water available ad libitum. Subjects were maintained on a 12-hour light-dark cycle (dim lighting 1 PM–1 AM; fluorescent lighting 1 AM–1 PM) and all testing was performed under red light four hours into the dark phase of this cycle. Each resident male was marked with a spot of blue liquid food dye to aid in identification. The ma-

mouse was challenged with a naive intruder during each test of aggression A total of 150 residents and 240 intruder mice were used in the two experiments

### Apparatus

The enclosure used for the experiments (Fig 1) consisted of a 60 cm square box made of 30 gauge sheetmetal The floor of the box was made of hardware cloth with small 0 6 cm square holes – holes small enough to prevent the mouse from sticking its head through and getting stuck The box rested on a 65 cm square pan covered first with paper and then layered 1 cm deep with sawdust bedding The sides of the box were 60 cm high and no top was required to keep the mice from escaping A tower 30 cm high made of small holed hardware cloth was anchored to the floor of the enclosure and provided an 8 cm square platform at the top for introducing the intruder When placed in the enclosure on the platform the intruder could climb down the tower to explore the enclosure or the resident could climb up the tower to reach the intruder

The enclosure was attached via a tube (4 cm in diameter 12 cm long) to a standard polypropylene mouse cage containing food water and bedding Although displays of aggression may occur in either the enclosure or the home cage they never occur in the tube the resident may however chase the intruder from one location to the other through the tube

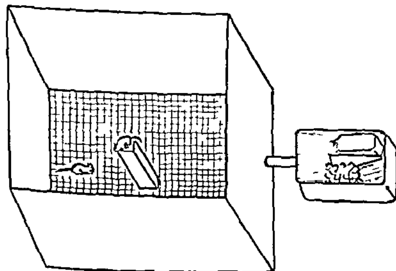


Fig 1 The experimental enclosure The box is 60 cm high and is connected by a tube to a home cage containing food water and bedding Note the 30-cm high hardware cloth tower in the center of the box

**Procedure**

A compl te description of the procedure used for measuring territori. sion using the enclosure has been described in a previous paper [Thurmo All mice were adapted for two weeks in the laboratory before the experi began Two cages each containing five mice were transferred to the test containing five identical territorial enclosures One cage of mice was rand designated as residents then each was marked for identification and pla middle of his respective enclosure If the resident mice are placed initiall home cage occasionally one of them will fail to enter the enclosure how placed in the enclosure they always explore it and end up in the home c conduct the test the five intruder mice were removed from their cage o was placed in the center of the enclosure box and the ensuing aggression corded during a 30 minute observation period Observations were made s of each pair of mice under the dim red light of the dark cycle An attack fined as a bout of activity lasting up to several seconds during which the bit the intruder at least once

Two experimental procedures were employed In experiment 1 reside were placed in the enclosures 0 hours (control) 6 hours or 24 hours pric duction of the intruder In the two treatment conditions the resident mi in the enclosure during four hours of the dim (active) phase of the dark c before testing For each of these conditions four repeated tests spaced on apart were conducted on the same ten resident males The residents were from the enclosures between tests and regrouped with their cage mates I periment 2 all resident mice were in the enclosure for 24 hours before t for aggression Groups of 20 residents were removed from the enclosure a vals of 5 30 45 60 and 180 minutes before aggression testing and then returned immediately to the enclosure Testing was also conducted on a c group which was not removed from the enclosure

Parameters recorded during the observation periods were the percenta residents attacking intruders latency to attack and number of attacks

## RESULTS

**Experiment 1**

The results obtained by changing the period of residence in the en [illegible] to introducing the intruder are given in Table I

The treatment effects obtained were analyzed by means of two fa[illegible] variance with repeated measures on one factor [Winer 1962 pp 30 31[illegible] tests of significance were two tailed The data of the 0 hour control gr[illegible] that the number of residents attacking intruders increased from an ini[illegible] value of 30[illegible] during the first test (week 1) to 60[illegible] during week 2 but d[illegible] crease beyond this value during subsequent tests When the residents w[illegible]

TABLE I Summary of Agonistic Behavior of Resident Mice Toward Intruders as a Function of Period of Residence and Repeated Testing Over a Four Week Experimental Period

| | | 0 hr residential period | | | | 6 hr residential period | | | | 24 hr residential period | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Week 1 | Week 2 | Week 3 | Week 4 | Week 1 | Week 2 | Week 3 | Week 4 | Week 1 | Week 2 | Week 3 | Week 4 |
| Percentage residents attacking intruders | | 30 | 60 | 60 | 60 | 60 | 70 | 80 | 80 | 90 | 80 | 90 | 80 |
| Latency to attack (min) | Mean | 17.3 | 10.3 | 8.5 | 10.6 | 18.5 | 14.2 | 16.2 | 12.1 | 11.7 | 8.3 | 7.5 | 7.1 |
| | SEM | 1.7 | 2.8 | 3.1 | 2.9 | 3.6 | 3.8 | 4.1 | 3.6 | 2.9 | 3.7 | 3.4 | 3.8 |
| Number of attacks | Mean | 1.7 | 7.5 | 9.0 | 6.9 | 18.0 | 15.9 | 14.9 | 15.2 | 26.1 | 35.3 | 24.8 | 33.9 |
| | SEM | 1.0 | 3.6 | 4.8 | 3.5 | 6.1 | 5.2 | 5.4 | 5.3 | 6.8 | 6.3 | 5.3 | 6.6 |

enclosure for six hours before testing the first time the number attacking the intruder was about 30% below that obtained for the 24 hour residence period but nearly equaled that of the longer period by the third week of testing. Application of a Chi square test to these differences in the number of residents attacking intruders would be inappropriate here since the groups across weeks of repeated tests are not independent. A comparison of the number of residents attacking intruders during week 1 for each group does not reach statistical significance ($\chi^2$ = 5.00, NS). However, the systematic increase in the number of residents attacking intruders over the four weeks of testing in the 6 hour group seems a rather clear indication that these animals became more aggressive. The number of resident males attacking when left in the enclosure for 24 hours prior to test was stable at 80–90% across the four weeks of repeated testing.

The latencies to attack shown in Table I for the 0 hour and 6 hour residents are longer than those obtained for the 24 hour residents ($F$ = 3.87, df = 2, 51, $P$ < 0.05). Values for this measure generally decreased monotonically as a function of repeated testing in each of the groups, a trend which reached statistical significance ($F$ = 5.16, df = 3, 81, $P$ < 0.01). There was no significant interaction of this variable with the different periods of residence ($F$ = 0.55, df = 6, 81, NS). The latency values for the 24 hour group averaged 55% of comparable values for the 6 hour group for each week of testing.

A greater number of attacks on intruders (Table I) was influenced by residence as the residential period increased from 0 to 24 hours ($F$ = 14.7, df = 2, 27, $P$ < 0.001). It can be seen that the number of attacks during the first test (week 1) for the 0 hour group was very low and increased during subsequent tests. However, changes in this measure during repeated testing over four weeks were less reliable than those observed for the latency measure ($F$ = 1.17, df = 3, 81, NS), although on the average the 24 hour group evidenced an increase of 55% more attacks than the 6 hour group. The interaction of changes in number of attacks over the four weeks with the different residential periods was not significant ($F$ = 1.29, df = 6, 81, NS).

## Experiment 2

Table II shows that the percentage of residents attacking their respective intruders increased as the time interval separating the disruption from the test for aggression increased ($\chi^2$ = 15.47, $P$ < 0.005). The effect of removing the resident mouse from the enclosures just five minutes prior to testing resulted in a marked reduction in the number attacking intruders compared to the controls which were not disturbed ($\chi^2$ = 8.05, $P$ < 0.005). The reductions in aggression obtained by removing the resident 30, 45, and 60 minutes before the test were essentially identical, the percentage of residents attacking in each of these groups being 40% lower than controls. When the disruption occurred three hours prior to testing the aggressive level of residents returned to that of controls.

TABLE II Summary of Agonistic Behavior of Resident Mice Toward Intruders as a Function of Disruption Prior to Testing (N = 20 residents in each condition)

| | | Interval prior to testing | | | | | |
|---|---|---|---|---|---|---|---|
| | | 5 min | 30 min | 45 min | 60 min | 180 min | No disruption |
| Percentage of residents attacking intruders | | 30 | 60 | 65 | 65 | 85 | 95 |
| Latency to attack (min) | Mean | 24 0 | 14 7 | 15 8 | 16 7 | 6 3 | 6 0 |
| | SEM | 2 3 | 2 8 | 2 6 | 2 6 | 1 4 | 1 5 |
| Number of attacks | Mean | 13 0 | 26 2 | 19 6 | 24 1 | 29 9 | 39 5 |
| | SEM | 5 5 | 5 8 | 4 5 | 6 5 | 6 2 | 4 7 |

Similar differences between the groups were obtained using the other two measures of agonistic behavior Group differences were analyzed using a one factor analysis of variance and where significance was obtained it was followed up with a test for comparison between treatment means by the Newman Keuls method [Winer 1962 pp 80–85] As in experiment 1 all tests of significance were two tailed The decrease in the latency to attack the intruder as a function of the interval prior to testing was significant (F = 9 12 df = 5 114 P < 0 001) Comparisons indicated that the 180 minute and no disruption groups differed from the five minute group (Newman Keuls P < 0 01) and from the (30–60) minute groups (Newman Keuls P < 0 05) Also the five minute group differed significantly from the (30–60) minute groups (Newman Keuls P < 0 05)

The increase in the number of attacks on intruders as the interval prior to testing increased (Table II) was significant (F = 2 63 df = 5 114 P < 0 05) The only comparison yielding statistical significance was between the five minute and the no disruption group (Newman Keuls P < 0 05)

## DISCUSSION

Previous work [Thurmond 1975 Thurmond et al 1977] had shown that 90–100% of CF 1 males attacked intruders if left in an enclosure for 24 hours prior to testing for aggression In experiments conducted by Oortmerssen [1970] on the tendency of different strains of mice to fight on their home ground a 24 hour period was also employed which produced aggressive resident males The results of experiment 1 indicate that males who reside in the enclosure for six hours are less aggressive toward intruders than those left in the enclosure for 24 hours before testing Thus although six hours would seem to be an appreciable period of residence in the small and relatively simple enclosure used the stimuli associated with the enclosure somehow induce a high level of aggression when the mouse is exposed to them for 24 hours

Repeated weekly exposure in the case of the six hour residents in[creased] th[e] o[c]currence of resident attacks on intruders but the latency of attacks a[nd] frequency of atta[c]ks on intruders did not reach those exhibited by th[e 24] residents In contrast repeated weekly c[o]nfrontation of the 24 hour res[idents with] an intruder had n[o] positive effects on the number of these resid[e]nts att[acking] intruders This result however was due mainly to the fact that 90% of thes[e] residents attacked intruders during the first test leaving little room for i[ncrease] in this measure during subsequent tests The measures of laten[cy] to atta[c]k a[nd] frequency of attacks on intruders indicate that aggression in th[e] 24 hour res[idents] tended to increase somewhat during repeated testing The stimuli in the e[nclosure] for inducing an ag[g]ressive readiness to attack intruders are likely to be r[elated to] the visual configuration of th[e] enclosure particularly the presence of th[e] [...] [Mackintosh 1973] and the odor of urine deposits in the en[c]losure [Ma[c]ki[ntosh] and Grant 1966 Ropartz 1968 Dixon and Mackintosh 1971]

Whereas the frequency of o[c]curren[c]e of CF 1 male mice attackin[g] intru[ders was] high following 24 hour residence in the enclosure it had been observed in o[ur] laboratory that it was also easily disrupted by certain events just prior to testing Loud noises or flashes of light seemed to leave the resident m[o]use r[elatively] unperturbed but even slight movements of the en[c]losure or brief att[em]pts to [handle] the resident were capable of profoundly decreasing the occurrence of atta[c]ks on an intruder Each of the m[e]asures of aggression employed in experim[e]nt [...] that removing the resident mouse from the enclosure five minutes before test reduced aggression toward the intruder to approximately 30% of control (no [disruption]) levels Resident aggression levels on the average were still 60% of control levels following the same disruption even 1 hour before introdu[c]tion of the intru[der] although they returned to control levels when the disruption occurred th[ree] h[ours] prior to testing It is not possible to determine from the results whether th[e re]duction in aggression is due to handling of the resident or to removal of th[e] animal from the stimuli in the enclosure which apparently indu[c]e an aggressive readiness during the period of residence Minor changes in an enclosure just pr[ior] to challenging residents with intruders seem to do little to reduce ag[gressi]on [Mackintosh 1970]

It appears from the results of the present experiments that an aggressive readiness develops in CF 1 male mice in the enclosure employed over a 24 h[our] period in the sense a) that mice left in the enclosure for as long as six hours [did] not display maximum levels of aggression toward intruders nor were maximum levels reached following four weeks of repeated testing under these condi[tio]ns and b) that somewhere between one and three hours are required for aggressi[on] to return to high levels in residents who are removed briefly from the enclosure near the end of a 24 hour period of residence

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
Volume 5 pages 173–177

# Book Reviews

## Peacekeeping Police Prisons and Violence by Hans Toch Heath Lexington Massachusetts and Toronto 1976 pp v + 137

Hans Toch s writing is unduly elliptical As an example police officers who casually approach men with guns Who have the guns the police or the men they approach? The "casually makes it the police but the reader has to stop to work it out Against this the writer sometimes sparkles suddenly An anything goes view of means has a way of including violence The wise guy on the beat or the opposing hockey player in a cut throat game may be casually dealt with because it doesn t really matter A similar stance can justify the rape of inmates and un dergirds poetry in report writing The last sentence stops one short but this time working it out is illuminating

Little has so far been written as Toch remarks about violence in formal organi sations Rules are one thing practice is something quite different It is easy to tell psychiatric attendants that disruptive patients may be restricted or immobilised *as a last resort* But what is a last resort? And what are the alternatives to physi cal restraint? More technical still since there are more and less violent ways of gettin patients into a camisole (here the reviewer in his Scottish ignorance must guess that this is not a flimsy female undergarment) how is the nurse to choose which ways to adopt? A patient curses and lifts a chair he is large and looks wild others are restive There is no time to consult a supervisor or wait for the doctor An action is taken and a precedent is set

In police and prison work as in psychiatric hospitals policy makers and directors in the background have to think of their executives in the face to face situation Given the fact that police and prison officers face potentially dangerous situations fairly regularly since their clientele are violence prone the organisation has to cope with fear – the fears of their staff as well as the fears of the dangerous clientele On both sides be it emphasised both lots come from social groups which believe that physical prowess and willingness to fight are *measures of manly worth.* The general program of the book is to work out ways of undermining the hold of vio lence promotive norms grounded in subcultural attitudes so strong as to be ac cept d without question as the natural law of the situation

The impression one gets possibly too hasty is that everything is still to be done The American Correctional Association Training Guide lists eighteen duties as com

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prising the work of guard personnel Of these only one – Hears inmate grie[illegible] and counsels inmates –envisages a relationship other than adversary or superv[illegible] between officers and inmates – and it is almost certain to be crowded out by [illegible] other seventeen rules mostly operating against the provision of time for often[illegible] inmate personal contact Of course that was in 1959 but a similar handbook [illegible] New York State current in the 1970 s *prohibits* the correctional service em[illegible] from engaging in any conversation communication dealing transaction asso- ciation or relationships with any inmate or former inmate or any visitor friend in any manner or form which is not necessary or proper for the discharge [illegible] the employee s duties Against that there are a few initiatives in the dire[illegible] mixing One is the ombudsman idea there are fourteen prison ombudsmen c[illegible] rently active in the US ten of them correctional staff members a device wh[illegible] *stimulates inmate scepticism But in two instance – Minnesota and Connecti[illegible]* the ombudsman has promoted staff inmate consultation and helped to reduce [illegible] flict and to relieve tension In police work the move from law-enforcement to peace keeping as the main police function is prospering here and there Toch s [illegible] and detached summary of this development is sobering His language is cons[illegible] hypothetical In team policing theory the police are brou ht closer to th[illegible] com[illegible] they can adjust their activities to community needs and can work closely with citizen representatives If this principle held the violence reduction potential would be obvious teen age gang members are not likely to play wise-guy[illegible] with a man in a yellow blazer who coaches their softball team riots do not f[illegible] *among spectators to an arrest that is inspired by a community plea voi ed in ch[illegible]* two nights previously

In general the badly needed attitude change is still in the future What pol[illegible] agencies are not doing is facing their involvements – the full gamut of their in volvements with pride The organisational reluctance to face service invol[illegible] ments is easily explained To face a service role means thinking of police as pre serving the peace not as combatting crime Where agencies – this appears to mean police departments experiment with service functions they meet im proved public acceptance Even modest efforts provide citizen esteem Th s give the police a greater sense of security They are consequently less apt to be trap[illegible] into responding to challenges taunts baiting and tests of manhood And *with these admirable propositions the book comes to an end*

Toch may be ignoring the more cheerful and sometimes more zany aspects [illegible] American prison life BBC television has just (October 1978) turned out a progr[illegible] about Fort Worth in which the prisoners are paired off male and female so that they may fall in love and so pacify and improve each other Many of them held [illegible] the pairing would probably not survive liberation The rule was that personal con tact while lavish must not occur below bench or waist level How this is manag[illegible] was not explained Toch s omissions are probably deliberate and probably do cre[illegible] to his good judgment

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**Anger Control by Raymond W Novaco Heath Lexington Massachusetts and Toronto 1975 pp xii + 134**

The appearance of this small book is fitting since as the author remarks the problem of human anger and its consequences is assuming substantial importance in developed societies of the 1970s Novaco s book deals with anger at the psychopathological end of the spectrum It reports a study designed to evaluate systematically the efficacy of several modes of behavioral psychotherapy in the control of psychopathological anger In reading the book this reviewer got the distinct impression of assessing a doctoral thesis or a lengthy journal article But the material it contains is sufficiently relevant and scientific to justify publication

The first chapter is a rather selective review of the literature on aggression While this selectivity is perhaps dictated by the nature of the book it is surprising that little mention is made of the literature on crowding and aggression since though this is often speculative it seems central to many of the issues of social importance raised in the concluding chapters

The primary importance of the book however lies in the two chapters outlining the design and execution of a study to evaluate methods of anger control The study was modest thirty four subjects took part in the psychotherapeutic programs aimed at controlling extreme anger In line with much psychological research subjects were drawn largely from a university population The statistical design is good

Criticism can however be made of some aspects of the assessment of anger Novaco makes much of an Anger Inventory evidently developed for this study Little is said of the psychometric aspects of its development no evidence is given for example of its validity In view of the availability of reputable instruments which might have been used to validate it and in view of the importance placed on the anger inventory as a measure of therapeutic change this is a glaring deficiency To be fair other means of assessment are also used but these measure anger only indirectly

The therapeutic program provides interesting reading indeed especially for clinicians who are increasingly required to help persons with problems of psychopathological anger It is based firmly on behavioral psychotherapy and particularly on the modification of cognitive activity an area that should be familiar at least to clinical psychologists Novaco has dissected the complex issue of anger control in a thoroughly logical way and therapeutic procedures are explained in admirable detail H nce clinicians should have little difficulty either in applying them or in

replicating the entire study in a research investigation Assuming the adequacy the measurements as valid indices of therapeutic change the results obta ed a impressive and clinically valuable Whether the value of such a program exte all the areas mentioned in the concluding chapters – the control of child abus aggression among police officers and so on – remains to be seen It does how deserve further examination

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**Cruelty and Kindness by Harvey A Hornstein. Prentice Hall Englewood Cliffs New Jersey 1976 pp vi + 154**

**The Psychodynamics of Hostility by Leon J Saul with Barbara Wrubel Jason Aronson New York 1976 pp x + 223.**

How do you study human kindness ? Well if you are a social scientist you devise experiments to test how people will respond to money left on the street lost wallets or you telephone strangers and ask for help Then you measure the results how many people returned the money and wallets or helped you on t telephone And you repeat the studies in other cultural contexts From these k of observations you synthesize a theory of behavior *But can the theory expla* altruism the subheading of the book? Perhaps but such theories make me u they grapple with complex human motives but derive evidence only from cont on the street manipulations I become even more uneasy when similar types of e periments are used to study aggression The proper understanding of aggression must involve at some point a detailed study of the criminal and the vi tim Ag gression research done with animals or within the setting of the laboratory is ve far removed from war and murder and rape Thus to extrapolate from the Mi g studies to a general theory of cruelty is a large inference Yet Hornstein a psy chologist has done it in this slim paperback which is somewhat popularized for easy reading And it does read well and is interesting But I kept asking Is it r *that simple? I wish it were*

On the other hand Saul has written a book describing psychoanalytic princi of aggression and clinical mechanisms underlying human behavior He discuss s examples and shows how they conform to intrapsychic mechanisms Guilt psych pathy and psychosomatic styles of coping are mentioned at length Later in the book the author talks of love and politics as more elaborate defenses and sublim tions concerning rage and hate I think the reader of this more complex volume will be interested in the intricacies of the unconscious but no doubt will be per plexed by the theory *which is so inaccessible to the average scientist* and cl To some extent Saul s work is the mirror image of Hornstein s the latter d als only with obvious overt behavior while Saul deals with the underlying motives

and conflicts which give rise to the behavior Saul switches at the end of the book to psychosocial considerations of violence He offers ideas for not only the prevention but also the cure for violence One cure he says is enough love That of course is always an interesting notion but is the answer also that simple?

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AGGRESSIVE BEHAVIOR
Volume 5 pages 179–219

# Abstracts of the Third Biennial Meeting of the International Society for Research on Aggression

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## HUMAN AGGRESSION A

Chair Ronald Baenninger Temple University Philadelphia

Frances J Fitch Alan Gold and John R Lion (University of Maryland Baltimore)
A Group Therapy Experience With Violent Alcoholic Patients

Because patients with violent aggressive behavior often show severe characterologic problems including impulsivity absence of guilt and difficulties maintaining stable intimate relationships they are frequently regarded as untreatable and generate discomfort in practitioners and trainees Little attention is given to them in allocation of psychotherapy resources or residency training

This paper describes a group of psychotherapy for violent alcohol abusing patients now in its fourth year Group work with these patients provides an appre

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ciation of the complexity of primitive character pathology increases s s n u and competent handling of countertransference aspects of their treatment a d p duces increased interest in and greater comfort with psychotherapeutic work w h them

Problems in establishing a referral base and its ultimate composition a e d s cussed including the screening and evaluation process criteria for accepta e a the initial therapeutic contract

The composition (diagnostic socioeconomic ) of the group patterns of atte d ance and typical group sessions (process and content) are described Importa recurrent themes and approaches that have been found useful are enumera ed These include alcohol use by members impulsive action either out of re r venge or "proof of masculinity with little regard for consequences anger and disappointment with spouses boisterous aggression to cover over passive l ra ings for intimacy and warmth frustration with bureaucracies and mistrust of authorities common defensive patterns of splitting denial and reaction forma tion Techniques of therapy are described Handling of crises by use of the t le phone hospitalization and occasionally discharge from the group a e discussed Demands on therapists by probation officers lawyers and courts are described

Concluding remarks on outcome for patients identify the therapeutic factors responsible for change Rewards for therapists are described including the d fe ent responses of five therapists who have worked with this group over its four ye existence

David Student and John R Lion (University of Maryland Baltimore)

Methodological Issues in Psychopharmacological Research of Violent Individuals

*To date no pure antiaggressive agent has been found* In search for a substa the authors have recently conducted a study of a drug found to have som effects in animals in preclinical investigations

Although many different pharmacological agents are used in the control of violent patients they affect the target sympton of aggression only secondarily The present use of these drug regimens and their rationale are discussed Theo retically a psychoactive agent may exist that affects the basic neural mechanisms involved in a gression

In order to experiment with such a potential antiaggressive drug and test its efficacy on violent patients an outpatient setting was chosen The advant es of studying drug effects in the natural habitat and of "victim participation and observation in the experimental design are thus maximized

Conducting a study of ambulatory violent patients however presents nume ous problems Recruitment of reliable patients with high measurable base lines of aggression is difficult Informed consent issues regarding patients on probation precluded their participation The dual role of investigator as observer and thera

pist and the dynamics particular to this group of patients and their families have to be constantly dealt with

Clinical observations are made of the four patients who successfully completed the eight week experimental period in comparison to the four who dropped out

The authors conclude that despite the difficulties of such a study there is need for further psychopharmacological research in the treatment of violent individuals

Henry Harbin and Denis Madden (University of Maryland Baltimore)

Battered Parents

This paper presents data that identify a new type of family violence problem the battered parent The victims are parents and the perpetrators of the violence are their adolescent and young adult offspring The authors discuss their experience in treating these families and delineate some of the dynamics associated with this type of family violence A primary focus of the presentation is on families in which the parents have been repetitively threatened with physical violence or actually assaulted and who have been unable to stop this established cycle of violence The dynamics of these families appears to be different from the dynamics of families in which child abuse or interspousal violence is the prominent feature

The authors base part of their observations on a research project currently under way that focuses on assaultive adolescents A surprising discovery was that a significant sub roup of these adolescents direct the majority of their aggression toward their parents rather than extrafamilially as is typical of many delinquent youth A variety of communicational and structural distortions in these families were also noted and summarized in the paper Another striking feature of these families is the manner in which the parents protect these aggressive youths even though the parents are the recipients of the violence The authors have treated a number of these families employing a variety of approaches including family therapy individual psychotherapy and pharmacological approaches In summary the paper attempts to delineate a new syndrome of family violence that has not yet been focused upon in the literature

Heino F L. Meyer Bahlburg and Anke A Ehrhardt (Columbia University New York)

Prenatal Hormones and Aggression in Man

This paper reviews the results of studies on human clinical models of abnormal prenatal hormone situations (endocrine abnormalities hormone treatment during pregnancy) and presents new data from a project on the behavioral sequelae of prenatal steroid treatment

Available studies on prenatally masculinized females have documented only statistically insignificant increases in physical or verbal aggression Data from stud

ies on males exposed prenatally to potentially antiandrogenic substances showed slight but significant decreases of aggressive behavior which however may be due to the effects of an abnormal pregnancy as well

We present data on 15 girls and 13 boys with less severe pregnancy conditions who had been exposed to medroxyprogesterone acetate (MPA) in utero and on 28 closely pair-matched control subjects The double-blind follow-up examination at age 9–13 years involved questionnaires half-structured interviews with mother and child separately and a battery of psychologic tests Interviews were tape recorded and rated by two independent raters

Analysis of the data on aggression shows no differences between experimental and control boys and only some borderline differences between experimental and control girls with some decreases of aggressive behaviors in the MPA–treated group We conclude that prenatal hormone effects on human aggression still have not been reliably demonstrated

Russell R Monroe (University of Maryland Baltimore)

Brain Dysfunction in Aggressive Criminals

Ninety three recidivist aggressive criminals at Patuxent Institution Jessup Maryland were assigned to four subgroups based on the interaction between central nervous system instability and dyscontrol symptoms Thirty percent of this population could be identified as a group of epileptoid dyscontrol subjects who not only admitted to dyscontrol symptoms on a self rating scale but also demonstrated evidence of central nervous system instability in the form of dru[illegible] EEG abnormalities This group also showed signs and symptoms suggesting mild neurologic disorders and gave a history suggestive of neurologic trauma They also had a childhood history suggesting the hyperkinetic syndrome A second group with equal evidence of an EEG abnormality but lacking other neurologic findings and dyscontrol symptoms revealed a severe psychosocial maladaption that is characteristic of the inadequate personality (*psychopath*)

A third and fourth group were identified as individuals whose criminality was more determined by psychodynamic or social factors Although the data were less clear it seemed possible that one group consisted of neurotic or "hysteroid" dyscontrol subjects while the other consisted of pure psychopaths The data suggest that this classification has specific prognostic and therapeutic implications

## HUMAN AGGRESSION B

Chair Suzanne K Steinmetz University of Delaware Wilmington

Gordon W Russell (University of Lethbridge Lethbridge Alberta)

### Hero Selection by Canadian Ice Hockey Players Skill or Aggression?

Since the turn of the century studies in which individuals usually children were asked to list the people they admire or most wish to be like have appeared with some regularity The analyses of such poll type data typically involved per centage comparisons of exemplar types across predetermined categories (eg politicians entertainment science relatives etc) Such investigations have served a useful purpose albeit a limited one in identifying influential societal models and indeed in drawing attention to some fairly important changes in model category preferences during the early decades of this century The selection of and identification with exemplars was assumed to be made on the basis of one or more attributes held in high regard by the youngsters

The hockey world has been torn with dissent in recent years over the issue of violence occurring both on and off the ice Part of the concern has centered on the influence of superstars on the values and behavior of youngsters Hockey offered an opportunity to quantitatively explore the nature of those bonds with exemplar choices Weekly cumulative statistics are meticulously kept on all National Hockey League (NHL) teams and players for devotees of the game Such records thus provide performance indices (goals assists) [Russell 1974] and measures of illegal aggression (penalties)

An approximation of a national sample of attitudes toward young ($\bar{X}$ = 18 5 $\sigma$ ~ 1 5) Canadian hockey players (N = 205) was obtained on the occasion of the staging of the 1975 Canada Winter Games in Lethbridge Alberta Subjects were asked to rank-order their favorite three NHL players and team favorites from among those currently active Regression analyses revealed that team choices were significantly related to their respective performance and aggression standings though more strongly to the former Individual superstar choices were highly correlated with performance measures but unrelated to aggression

The subjects also tended to select as exemplars NHL players who play the same position as the respondents Finally NHL models tended to be selected by subjects from the professional teams operating in the subjects own Canadian province The results were discussed within the framework of social learning theory

Jo Groebel and Dagmar Krebs (Institut fur Psychologie Aachen Federal Republic of Germany)

Perceived Situations Anxiety and Their Effects on Aggression

Beside the studies on the effects of violent TV programs on aggression an increasing number of authors draw attention to the effects of these programs on anxiety In this context Bandura s imitation learning theory does not seem sufficient to explain the development of anxiety Although an anxious model may be imitated the perception of a threatening situation shown in fictive or real-tive aggressive films and a generalization to the actual environment may have a effect on the anxious perception of this natural environment even if the TV hero does not show any fear In our study we were not interested in the immediate fear reactions in front of the TV set associated with physiological arousal and state anxiety but in the development of a cognitive pattern connected with "trait anxiety

Two dimensions social anxiety and physical anxiety seem to be of particular interest in the study of the effects of violent programs as most of the situations *shown on TV either induce one or the other In addition different characteris*tics of the watching person (sex dispositions like neuroticism experience with similar situations) and of the observed situations (amount of aggressiveness shown reality content etc) are interesting If anxiety appears within the natural environment this may lead to aggression as has been reported for social fear

In a longitudinal field study that ran over three years an experimental group of 405 children 11 15 years old was investigated once per year using an anxiety inventory (Aachener Angstfragebogen consisting of two factors social anxiety and physical anxiety factor structure stability over time 0 98) an aggression scale and other measures That there were no measurement effects was shown through the inclusion of control groups each investigated only once

Results (based on a hierarchial analysis of variance) Girls reported higher anxiety I and II than boys (P ⩽ 0 001) high neurotic children had higher anxiety scores than low neurotic children (P ⩽ 0 001) Children who saw the fictive aggressive films as realistic had higher anxiety scores (I and II) than boys and girls who believed that the aggressive films were unrealistic (P ⩽ 0 05 no differences for nonaggressive films) The same result was found for a semidocumentary serial shown on German TV Over time there was no significant decrease or increase of anxiety but the results reported above were reproduced in the three replications On the basis of multiple regression analysis anxiety II (social) turned out to be the best predictor (simple $r = 0.40$) for boys aggression.

So far it can be concluded that there is a strong relation between the perceived reality content of aggressive films and anxiety and a strong relation between boys social anxiety and aggression

Dagmar Krebs and Joe Groebel (Institut für Psychologie Aachen Federal Republic of Germany)

Confrontation With Aggression in Day to-Day Life and Its Manifestation in Attitudes Toward Aggression

The considerations and results presented in this paper are based on a longitudinal field study on the effects of television violence on aggression and anxiety in children 12–15 years old

Aggression in our study is not related to behavioral acts of aggression but to attitudes toward aggressive acts There are three dimensions of attitudes toward aggression empirically established in pilot studies a) attitude toward destructive aggression b) attitude toward reactive aggression and c) attitude toward positively sanctioned or legitimate aggression (eg violent acts by the police)

In studying television s possibly detrimental effects on the viewer it seems reasonable to investigate the effects of televised violence not only on open acts of aggression but also on attitudes toward aggression for the viewer elaborates and evaluates the television diet in the frame of reference of his cognitive system

The argument is that the viewer may extract behavioral rules from television programs especially he may perceive some violent events on television as real and may develop a conviction that conflict resolution or goal attainment by use of aggressive modes of action is highly efficient It is possible that although this conviction seldom or never leads the viewer to open acts of aggression it is discovered at the merely attitudinal level

The central hypothesis is that television viewing is only one and surely not the most important part of everyday life influencing the viewer s attitudes toward aggression There are many other factors and real experiences that may be considered in this context Presumably observing violent acts in television is not as concrete an experience as observing violent or aggressive acts in the neighborhood or between peers Further being victim of an aggressive act and acting aggressively when alone are even more direct experiences than vicarious experience of violence or aggression in peers or on the television screen

We suppose that the actual day to-day experience of a person influences his attitudes toward aggression more than the vicariously experienced violence on television At least these daily-life experiences have a mediating effect on the relation between attitude and television fare because one can reasonably assume that a violent environment leads a person to judge television violence and aggressive film sequences as real and therefore makes him more liable to be influenced by the rationale of the aggressively behaving models on television

Finally one can postulate that in an imagined hierarchy of concreteness television plays a less important part in influencing or reinforcing attitudes than do actual daily experiences with aggression eg observing actual aggression being victim of aggression or acting aggressively oneself

Monroe M Lefkowitz (New York State Department of Mental Hygiene Alban

Violent Television Preference and Depression

Many studies have reported a relationship between a diet of violent televis n viewing and aggressive behavior in young male children Moreover the data strongly indicate that the relationship is causal Violent television engenders ag gressive behavior To this writer s knowledge no data are extant concerning th possible relationship between violent television and other kinds of psychopathol ogy Consequently the present study examined this relationship in two groups of subjects for which measurements on television violence and psychopathology were obtained In the first group data were gathered on television program pref erences from 211 male and 216 female subjects whose modal age was 19 years In addition the Minnesota Multiphasic Personality Inventory (MMPI) was admin istered to all subjects A statistically significant relationship was found between violence ratings of program preferences and the depression scale of the MMPI but only for females The data also suggested that self-esteem was lower for th females who preferred violent television These empirical findings prompted collection of data from a second group comprised of 585 children – 334 females and 251 males – whose modal age was 10 4 years Television viewin preferences and self ratings of depression and self-esteem were obtained from each child Based on the prior findings for young adults it was hypothesized that a prefer ence for violent television would be related to depression in this sample of chil dren To strengthen the test of this hypothesis a multimethod approach to th assessment of television violence and depression was used Essentially the earlier findings on adults were repeated for children A statistically significant relation ship between television violence and depression across both methods was found for females Self-esteem was also significantly lower for those females prefern programs containing television violence The results for males however were equivocal Theoretical considerations to account for the findings of this study are presented

## HUMAN AGGRESSION C

Chair Richard J Borden Purdue University West Lafayette Indiana

Ann M Frodi and Michael E Lamb (University of North Iowa Cedar Falls)

Parents Responses to Infants at Risk for Child Abuse

Demographic evidence suggests that premature infants are three times more at risk for child abuse than any other category *In one study by the present authors,* it was found that a crying infant elicited significant autonomic arousal and feel-

ings of anger and aversion particularly when the infant was labeled as premature whereas a smiling infant elicited pleasant emotions and negligible physiologic changes In a replication and extension of this study an attempt was made to assess independently the effects of the auditory and visual characteristics of "normal" and premature crying infants on parents autonomic responses and self reported emotions Four six minute videotapes were prepared which recorded 1) a normal infant with its normal cry 2) normal infant – premature cry 3) premature infant – premature cry and 4) premature infant – normal cry Thirty two parent couples (N = 64) were randomly assigned to these four conditions Heart rate (HR) skin conductance (SC) and blood pressure (BP) were monitored while the parents viewed the videotape Thereafter self report measures were administered Few sex differences were found on either physiologic or emotional indices The infant cry triggered significant HR BP and SC increases in mothers and fathers as well as negative emotions indicating anger or aversion More importantly these responses were significantly stronger to the premature cry than to the normal infant s cry Aversive reactions and autonomic arousal were particularly pronounced in those parents exposed to both the auditory and visual cues of the premature infant Incorporated into Berkowitz s model of impulsive aggressive behavior these results suggest that specific physical and behavioral characteristics of premature infants might well contribute to rendering these infants at risk for child abuse

Michael T Hynan (University of Wisconsin–Milwaukee)

Shock Delivery in Human Aggression Experiments Aggression or Button Pushing?

The construct validity of shock delivery as an indicant of aggression was investigated in a new paradigm of human aggression After completing the MMPI (scored on 24 scales) and Blackburn s scales of hostility and aggression 140 college students engaged in a competitive game with a research assistant (identified as such) The subject and the assistant were seated at opposite ends of a table facing nearly identical equipment panels Each game was a race to determine which competitor would be first to score 300 points on a scoreboard by repeatedly pressing a telegraph key In addition both competitors had the option of blocking the progress of the other for five seconds by pressing a second lever on their respective panels Also the subject had the option of delivering a brief shock to the assistant s hand by pressing a button on the panel In one condition (noninstrumental) a shock response served only to deliver shock In a second condition (instrumental) the shock response also terminated a block delivered by the assistant Assistants were actually shocked The 26 personality scales were factor analyzed into three factors I) anxiety vs ego strength II) repressiveness vs expressiveness (aggression) and III) degree of psychopathology Multiple regression analyses indicated that

factor scores from the three factors did not predict use of shock in the instr mental condition In the noninstrumental condition the three factors did pr shocking factor II accounting for 18% of the total variance in shocking Th struct validity of shock delivery as an indicant of aggression appears to be si tion-dependent

Jacquelyn Gaebelein and Kenneth Gruber (University of North Carolina at Greensboro)

Effects of Target Variables on Third Party Instigated Aggression

This presentation reports the results of a series of studies that have exam the long term consequences for a target of aggression in the third party insti aggression paradigm

The first findings noted suggest that a subject s role as either aggressor (w directly attacks) or instigator (who instructs another to attack) affects the amount of aggression directed toward the target In general nonprovocative victims are the targets of more aggression when a subject is an instigator rath than a direct aggressor

The second general set of findings suggest that subjects tend to be more i enced by the current behavior of their targets than by past experience In a r ber of studies a two phase procedure examined the aggression directed towar the target in phase 2 as a function of events which occurred in phase 1 Gen erally subjects tend to direct more aggression toward a provocative than a nc provocative target when the target is the same as in phase 1 but if the target a different person both the target s provocativeness and subjects past experie with aggression predict subsequent aggression

This series of studies provides evidence against the frustration aggression hypothesis and questions the utility of the displacement-of aggression constr A social learning perspective which emphasizes the interaction of past and cu variables best explains the data collected to date Specifically the clearer the present situational demands for aggression the less predictive are past a ress experience the more ambiguous the current situation the more likely past ex perience of responding aggressively predicts continued aggression

Christina J Johns (Michigan Department of Corrections Lansing)

Female Partners and Male Police

Sixteen male State Police Troopers with either a male or a female partner r sponded to a training film designed to provoke impulsive aggression Troopers and partners fired blank loads directly at a movie screen when they felt it wou have been appropriate to do so had the situations depicted in the movie been occurring in real life The hypothesis that female presence would affect shooti

responses of male troopers was confirmed Troopers with female partners fired more often and with fewer nonshooting errors than did troopers with male partners The results are discussed in terms of three models of aggressive behavior and the practical applications of the findings

Vladimir J Konecni (University of California San Diego La Jolla)

Relationship Between Aggression and Experimentally Induced Negative Emotional States (Anger Fear Disappointment)

Recent studies have shown that an opportunity to hurt physically an insulting person tends to reduce the amount of subsequent aggression directed by angered people against the annoyer (the cathartic effect ) This finding has been interpreted in the context of a more general model of interpersonal aggression which proposed that there is a relationship of *bidirectional causality* of degree of anger and amount of aggression expressed such that a) the higher the degree of anger the greater the amount of aggression and b) aggressive actions performed by angry individuals may reduce the degree of anger by virtue of decreasing the level of cardiac arousal (perhaps because the prevailing real life contingencies lead to pairing of aggression with a decrease in arousal that accompanies the removal – through aggression actions – of noxious social stimulation) Such considerations suggest that every instance in which aggression alleviates anger would increase the probability that aggression would occur in future cases of anger induction The present explanation of the cathartic effect thus has implications for delayed aggressive behavior its predictions though not the proposed underlying mechanisms are similar to those derived from the social learning theory

To investigate such issues an experiment was performed to compare the effects of pairing insult induced anger with a) aggression against the insulting person b) a nonaggressive activity also known to have arousal and anger decreasing properties (soothing computer generated melodies" at 4 00 bits/tone) and c) a neutral activity unlikely to lead to a fast decay in arousal and anger After these manipulations subjects read light material for 15 minutes to allow a complete arousal decay and then were again angered (by a different method) in certain conditions and not angered in others Finally all subjects had the opportunity to express aggression against the person who had originally insulted them and to expose themselves to the soothing computer-generated melodies ad libitum (these were nonredundant dependent measures) It was found that in comparison with the various control conditions (there was a total of nine conditions with ten subjects in each) subjects whose original anger had been paired with aggression *and* who were then angered again subsequently aggressed far more than subjects in any other conditions In contrast subjects whose original anger had been paired with soothing melodies reacted to the second anger epi

sode by listening to the soothing melodies a great deal (more than in the appropriate control conditions) and aggressing very little (less than in the appropriate control conditions) The predictions were thus fully confirmed

Two additional experiments explored the effects of pairing aggressive and nonaggressive activities with other negative emotional states (fear disappointment) on the amount of aggression following a subsequent induction of the same negative state As predicted the results differed from those in the case of anger The theoretical reasons for the differences as well as the findings from additional related experiments are discussed

## *HUMAN AGGRESSION D*

Edward Donnerstein (Iowa State University Ames)

Effects of Erotic Stimuli on Aggression Against Women

Although the 1970 Presidential Commission on Obscenity and Pornography concluded at the time that there was no evidence of a relationship between exposure to erotic forms of presentations and subsequent aggression particularly sexual crimes recent criticisms of these findings have led a number of investigators to reexamine this issue Specifically research by a number of individuals has indicated that under appropriate conditions exposure to erotic forms of media presentations can facilitate later aggressive behavior While this research has been directed at the question of erotic effects on behavior the issue of whether such media presentations can in some manner be related to increased aggressive attacks against women has been of only recent concern The present paper discusses a series of recent investigations that have examined the conditions that might facilitate aggression towards women as a function of erotic exposure On the basis of this research which has investigated both the behavioral and physiologic reactions of male subjects to erotic exposure it is concluded that certain situations that allow for a reduction in inhibition of aggression can act as to facilitate aggression toward females The implications of this research for future studies on erotic film content and individual differences in this area are discussed

Dick Moriarty and Ann McCabe (University of Windsor Windsor Ontario)

Studies of Television and Youth Sports Laboratory/Field Research on the Effects of Prosocial and Antisocial TV Models on Children and Youth

This study reports the results of a research project commissioned by the Ontario Royal Commission on Violence in the Communications Industry The purpose of this study was to describe the growth and development of TV sports/

athletics aggression and violence and to assess the effects of prosocial and anti social TV sports/athletics on children/youth in Little League baseball minor la crosse and summer hockey The study was conducted in a classical test/retest research design utilizing the SIR/CAR system Audio and written opinionnaires were utilized to assess TV viewing habits basic disposition of the children/youth to professional athletics or amateur sport organizational models and attitudes feelings and interactions of children/youth and their parents through a TV diary Binocular rivalry was utilized to test the effects of prosocial antisocial and con trol instructional TV inputs on the perception of violence and aggression by the children Behavior before and after exposure to prosocial and antisocial or con trol TV tapes was monitored by TV slides and personal observation Behavior of children/youth while viewing the TV treatment tapes was also monitored The results showed that exposure to antisocial TV models did not significantly change the behavior of the children/youth while exposure to prosocial TV models did appreciably reduce physical and verbal aggression (while marginally increasing symbolic aggression)

Christina J Johns (Michigan Department of Corrections Lansing)

Evolution of Legal Traditions in Mexico

Solutions to social problems in any society are the product of the evolution of that society To understand the solutions one must understand the evolu tionary process of the society itself The intent of this article is to provide the reader with a broad understanding of the evolution of legal traditions in Mexico that have shaped legal solutions to social problems The focus is on the legal tra ditions of two of the major pre-Conquest Indian civilizations the Aztec and the Maya the more important legal issues of the Spanish Conquest and the Spanish legal legacy and the social situation of law and order in Mexico from 1808 to the present There are three themes that are crucial in considering the history of criminal law in Mexico They are 1) a societal orientation toward severity of punishment 2) a tradition of disrespect for law and 3) continued attempts to bring about *order through* violence The three sections of the article in turn stress these themes

Patricia H Powell (Purdue University West Lafeyette Indiana)

Human Animal Aggression An Examination of a Neglected Topic

A survey of existing psychological literature indicates a steadily increasing number of investigations of aggression between humans and of aggression be tween animals Surprisingly few studies have addressed the issue of human ani mal aggression In part this neglect is due to the definition of human aggression against animals as predation Nevertheless little information exists regarding either the motivations for human animal aggression or inhibitions against it Ex

tant literature can be classified as 1) psychoanalytic interpretations 2) inves tions of animal vs human victims and 3) studies of attitudes toward animals hunting Studies of attitude provide the most lucrative approach for underst ing harm doing behavior It is suggested that this approach be refined to addi specific topics regarding aggression against animals An understanding of the terminants of human animal aggression would provide insight into many curr social problems Issues of human human aggression and species preservation well as human treatment of our earthly cohabitators can all be addressed wi an understanding of human animal aggression

Richard J Borden (Purdue University West Lafayette Indiana)

Towards a Theory of Human Animal Aggression

Despite a growing interest in the determinants of human-human a ression and animal–animal aggression very little theoretical attention has been direc toward an understanding of human animal aggression In part this neglect ma stem from the traditional and perhaps restrictive definitions of a gression used by many researchers Nonetheless human exploitation of animal victims is a widespread and apparently increasing phenomenon This presentation is d signed to examine the theoretical factors that can explain the unique relation-ships that occur between the human and nonhuman animal species Particular emphasis is focused on the role of individual situational and sociocultural d terminants of animal victimization Further a theoretical review of the ways i which emotions values needs and habits combine to influence willingness to utilize animals is provided In addition to providing a framework for guiding hypotheses and research on this topic this presentation also organizes a conce tual language for a psychological understanding of human animal relationships

## HUMAN AGGRESSION E

**Chair Dagmar Krebs Institut fur Psychologie der Rheinisch Westfalischen Tec nischen Hochschule Aachen Federal Republic of Germany**

Carl W O Nell (University of Notre Dame Notre Dame Indiana)

Some Child Rearing Practices Contributing to Nonaggressive Behavior in a Zapotec Community

Research in the Valley of Oaxaca (largely among Zapotec speakers) disclose the side by side existence of relatively aggressive and nonaggressive comm nitie (Some of these communities have been labeled violent/antiviolent or hi h-hom

cidal/low-homicidal communities in other research done in Oaxaca ) Differences along the dimensions of aggression/nonaggression in these communities *are not really explained* with reference to differences in cultural traditions (they all more or less share in the same dominant cultural tradition) differences in demographic factors or differences relating to ecologic situations Furthermore there is no clear-cut or explicitly stated religious or philosophic ethic demarcating aggressive and nonaggressive communities

My own research in several field trips over the last ten years leads me to believe that differences in aggressive and nonaggressive social behaviors relate principally to three categories of variables The categories are 1) cognitive orientations toward the relative acceptance or nonacceptance of interpersonal aggression as a common solution to human problems 2) differing emphases on the values placed on the quality of interaction in interpersonal relationships 3) differing practices and expectations in the rearing of children The variable categories referred to in 2 and 3 above are assumed to be supportive of variable category 1 The ethnographic data at least strongly suggest this to be the case in relatively nonaggressive communities While reference is made in this paper to each of these categories of variables the focus is placed on certain empirically relevant child rearing practices which appear to be closely related to customary social behaviors in a nonaggressive Zapotec community well known to the writer Differences in the seriousness of various childhood offenses and how these offenses are handled by parents (based on interviews with fathers and supported with field observations) will be discussed The implications of these practices in the development of a predominantly nonaggressive cognitive orientation will be explored

Jerome R Corsi (University of New Mexico Albuquerque)

Terrorism as a Desperate Game An Analytic Step Toward Comprehension of Fear Bargaining and Communication in the Terrorist Event

This paper views terrorism from an analytic framework After a definition of terrorism is advanced a typology is presented to identify four different types of terrorist events and characteristics particular to each The typology is generated in a 2 X 2 block utilizing the following dimensions a) terrorist intent ie whether terrorists intend or do not intend to capture persons or property b) target location ie whether the location of the target is known or unknown Most importantly this typology permits distinguishing types of hostage taking from attack terrorism Following this the negotiations involved in hostage taking situations are examined in some detail with emphasis on governmental response options and event outcomes Decision routes are mapped as a method for conceptualizing the tactics involved in bargaining communications

Lawrence Z Freedman (University of Chicago) and Harold D Laswell (
University, New Haven)

The Dimensions of Terror

ABSTRACT MISSING

## ANIMAL AGGRESSION A

**Chair Paul F Brain University College of Swansea Swansea Great Brit**

Douglas Fry (Indiana University Bloomington)

An Argument Against Group Selection Explanations for Ritualized Aggr

Ritualized aggression that usually does not end with serious bloodshe common in many animal species but its evolution is often accounted for of group selection For instance Lorenz Eibl Eibesfeldt and others prop rivals are not killed or seriously injured in within species aggression becau would endanger the survival of the species Here however it is argued t cial patterns of interaction such as ritualized aggression should be exami terms of their effects on the fitness of the individuals actually engaging in behaviors – that is in terms of updated Darwinian evolutionary theory – group adaptations are simply assumed to exist Maynard Smith s concept evolutionarily stable strategies for interpreting aggression at the individ level and Hamilton s theory of individual inclusive fitness provide an alter theoretical framework to group-level explanations Examples of animal a sion previously interpreted in terms of species advantage are explained thr this updated Darwinian approach

Additionally it is noted that while there is a growing consensus amon tionary biologists that selection above the level of the kin group (ie group tion) is not the primary force in the evolution of social behaviors many re searchers in other disciplines being unaware of the problems with group- species level explanations continue to consider the evolution and function aggressive behavior in terms of group or species benefit Thus by makin th level of selection issue explicit it is hoped that a communication gap be disciplines may be partially bridged and that group level assumptions frequ taken for granted may be critically reexamined

John F Knutson and David J Fordyce (University of Iowa Iowa City)

Light Controlled Social Experiences and Aggressive Behavior in the Rat

In a series of recent experiments the influence of colony lighting on both home-cage aggression and shock induced aggression was demonstrated These studies indicated that subjects raised under a light-dark (LD) light cycle generally display more aggression than subjects raised under 24 hr light (LL) conditions Furthermore these aggressive behaviors manifested a sinusoidal rhythm in LD groups but not in LL groups The present experiments were conducted to determine the role of light synchronized social experiences as a factor that mediates these lighting influences on aggression

The first experiment assessed the role of light synchronized interactions by raising blinded and sighted subjects in cages housing either blinded or sighted cagemates under LD conditions The results of this study indicate the necessity of a light cycle in determining periodic group rhythms in home-cage and shock induced aggression Furthermore this experiment provided data that suggested that social interaction is not a potential Zeitgeber for subjects lacking a light cycle Zeitgeber

The second experiment also raising blinded and sighted subjects with blinded or sighted cagemates maintained subjects under LL conditions This experiment provided data that suggest that the reported reduction in aggression in LL subjects was due to a constant light produced hypoactive state and not due to the absence of aggressive experiences The frequency of home cage and shock induced aggression in blinded rats raised with sighted cagemates was less than that displayed by blinded rats reared with blinded cagemates On the basis of these data it was concluded that social experience can influence shock induced aggression but the effect is relatively slight

Richard McCarty (Laboratory of Clinical Science National Institute of Mental Health Bethesda Maryland) and C H Southwick (Johns Hopkins University Baltimore)

Food Deprivation Its Effects on the Predatory Behavior of Southern Grasshopper Mice (Onychomys torridus)

The grasshopper mouse (Onychomys torridus) is a predatory and aggressive rodent native to the semiarid scrub deserts of the southwestern United States and northern Mexico Its natural diet consists mainly of arthropods and small vertebrates In this study we have evaluated the effects of food deprivation on the predatory behavior of adult male and female grasshopper mice to crickets

and laboratory mice (Mus musculus) No sex differences were observed in t predatory behavior of grasshopper mice to living or dead crickets Subjects were deprived of food for 48 hr spent more time eating and tended to cons more prey than did controls that were provided with free access to food W food available ad lib 6 of 43 (14%) male and 22 of 45 (49%) female grassh mice killed and ate Mus opponents within 48 hr of pairing When deprived food for 48 hr 16 of 36 (44%) males and 15 of 19 (79%) females that were killers in the previous experiment killed and ate Mus opponents Thus, food deprivation and type of prey are two factors which influence the predatory havior of grasshopper mice

Sami Al Maliki and Paul F Brain (University College of Swansea Swansea Great Britain)

Studies on Different Forms of Aggression in a Laboratory Mouse Strain

A number of authors have proposed schema to classify types of aggressio These classifications have arisen from the generally accepted conclusion that concept aggression encompasses a diverse group of activities that are linke simply by the fact that they cause actual or potential harm to another indivi There have already been a number of attempts to contrast different forms o gression in the rat The laboratory rat has proved in the past however to be appointing research animal as it has been difficult to induce spontaneous" a gression in this species Consequently a series of studies have been carried ou using albino laboratory mice of the Tuck 'TO strain (these animals have al ready been used in a variety of hormone/aggression correlations) Males of th strain readily show intermale or rank related fighting in standard oppo nent tests following short periods of isolation or cohabitation with a female the first series of studies the effects of simple experimental manipulations on rank related fighting in a standard opponent test were contrasted with t influences on locus killing behavior (a form of predatory aggression?) in the s animals Variables such as ontogeny sex behavioral experience (locust killin or mouse attack) housing condition (isolation or grouping) social rank (dom nant or subordinate) performance in a predation test 36 hr of food deprivati olfactory cues (sham perfused or rendered anosmic) and gonadal function (sh castrated or castrated) all differentiated between these two forms of a gressio The conclusion reached was that rank related and predatory aggression have v different physiologic bases

Additional experiments will be described in which rank related and/or locu killing are contrasted with other forms of aggression These include matern aggression (seen in lactating female mice) a form of territorial aggression generated by using a series of interconnected cages and pain induced aggres sion induced by unavoidable electroshock Again differences between the di

ferent models were apparent It is suggested that workers should where possible look at a variety of models before making statements about the effects of treatments on aggression

## ANIMAL AGGRESSION B

Chair David B Adams Wesleyan University Middletown Connecticut

Robert J Sbordone (University of California Los Angeles)

Mescaline Induced Pathological Aggression in Rats An Explanation of the Phenomenon

The species typical aggressive repertoire of a pair of rats in response to foot shock consists of both rats assuming upright boxing postures and striking each other with their forepaws Aggressive behavior of which topography and severity significantly exceed this repertoire can be operationally defined as "pathological When mescaline is administered to a pair of rats in conjunction with foot shock their behavior appears to qualify as pathological since rather than box with an opponent they will engage in vicious biting This effect has been shown to be highly reliable and relatively unaffected by the size of the testing chamber fighting experience shock termination experience with the drug and a e or strain of the animals

Two studies are reported in which mescaline s effect on both the victim s and the attacker s behavior was investigated In the first study the topography of the attacker s aggressive behavior was found to be related to specific behaviors elicited by the victim immediately prior to an attack In the second study the severity or the extent to which the biting attacks produced physical damage to the victim was found to be related to EEG changes in the attacker These results suggest that mescaline induced pathological aggression in rats is due to changes in both the victim s and the attacker s behavior

Michael Potegal Alan Blau and Murray Glusman (City University of New York Flushing)

Suppression of Aggression in Hamsters by Stimulation of the Septal Region

We have recently observed an apparently specific form of aggression inhibition in hamsters produced by stimulation of the septal area Our subjects were individually housed male golden Syrian hamsters 3–4 months old selected for aggressiveness and implanted with chronic movable electrodes held with a spring clip skull anchor These subjects readily attacked nonaggressive target hamsters that were pretreated with an analgesic and muzzled to prevent retaliatory biting

After evaluation of subject s base line attack rates on targets placed in their ho cage the subjects were stimulated in the septal region with 0 1–millisecond bi phasic pulses at 100 pps

At current levels that did not produce any motor automatisms or stereotyp competing responses septal region stimulation prevented the initiation and su pressed the ongoing performance of subjects attacks on the targets Stimula tion at minimum current levels necessary for aggression inhibition (35–150 μ has had no effect on acceptance of sunflower seeds (a highly preferred food fo hamsters) in any animals tested to date In two-thirds of the animals tested to date this stimulation also has not inhibited copulatory behavior with a recep female Recordings from the stimulating electrode before and after stimulation have not yielded any indication of seizure activity Preliminary tests of the re forcing value of the stimulation in an operant chamber indicated that the stimu tion may be moderately aversive There is some indication that this aversiveness may be minimized when aggression-suppression occurs at lower current levels These results extend previous reports of septal inhibition of predatory and de fensive aggression to include effects on intraspecific aggression

D Benton P F Brain and J F Goldsmith (University College of Swansea Swansea Great Britain)

Involvement of Various Sensory Modalities in Isolation Induced Aggression in Laboratory Mice

Studies of the involvement of olfactory tactile and visual cues in the devel opment of isolation induced aggression were reported

The olfactory input of individually housed male mice was decreased by nasal infusions of zinc sulphate a process found to be associated with a decreased in cidence of threat and fighting The possible role of pheromones was examined b exposing individually housed male mice to the soiled bedding from various groups of mice Isolated males in the presence of bedding from groups of female displayed significantly less aggression than those in the presence of the bedding from group-housed male mice

The removal of the mystacial vibrissae increased the tendency for mice ex perienced in fighting to attack However their removal had only a little influen on the development of isolation induced aggression

Mice able to see other animals through perspex screens were as a gressive as traditionally housed isolates However individual mice separated by perforated zinc screens displayed lower levels of fighting

In most laboratories so-called isolated animals are merely physically separated from conspecifics which they may be able to see smell and hear Preliminary experiments were reported in which mice were as far as possible totally iso lated There was a suggestion that total isolation may suppress fightin to a small extent

It was concluded that one factor influencing isolation induced aggression is physical separation olfactory cues also have a significant influence but visual information seems relatively unimportant

## SYMPOSIUM CONSEQUENCES OF SOCIAL ISOLATION UPON PRIMATE BRAIN DEVELOPMENT AND BEHAVIOR

Chair James W Prescott National Institute of Child Health and Human Development Bethesda Maryland

Discussants Robert S Dow Good Samaritan Hospital New York Ray S Snider University of Rochester Rochester New York Al Globus University of California Davis

During the past 25 years a wealth of behavioral data have been obtained upon the developmental consequences of rearing infant monkeys in simple cages in which they are deprived of somesthetic and vestibular sensory stimulation that is ordinarily provided by the mother and peers in a normal rearing environment These studies that were initiated by the Harlows in the mid 1950s have documented the depressive withdrawn autistic like stereotypical and chronic self stimulation behaviors in infants reared in isolation and the hyperactivity hyperreactivity and pathological violence in juvenile and adult monkeys reared in isolation The studies of Mason and Berkson have implicated vestibular sensory processes in the development of these pathological social and emotional behaviors consequent to isolation rearing It has been suggested by Prescott that these isolation rearing conditions constitute sensory deprivation of the somesthetic and vestibular modalities which induces neuromorphological neurochemical and electrophysiological abnormalities in the developing brain The cerebellum was particularly implicated in the mediation of the isolation rearing syndrome

The objective of this symposium is to review recent findings of neuropathology resulting from primate isolation rearing special attention being given to the role of the cerebellum in the mediation and regulation of sensory social and emotional processes in the infrahuman and human primate

A H Riesen P Lehr B J Sonnier and R G Struble (University of California Riverside)

### Branching Differences in Stellate Cells Related to Cortical Area and Rearing Environment of Monkeys

Varying conditions of somatosensory stimulation and motor activity were imposed during rearing to investigate possible differences in layer IV stellate cell

branching brain proteins and behavioral development as functions ments Samples for determining stellate cell development and for bi determinations were taken from sensory cortical areas (visual soma and II) and from motor (M I M II) and premotor frontal cortex A stumptail macaques (M arctoides) born in the laboratory were rean each of four conditions condition I – a 12-in X 12 in transparent l with grille floor An attached bottle with protruding nipple and a fe containing monkey chow gave opportunity for some object manipu tion II – a 48 in X 48 in transparent cube with bottle and hopper c same as condition II with the addition of sloping ladder a horizont a swinging trapeze and play objects (small cube ball rod) conditio immediately adjacent large colony room in which "controls" were r view of all other animals by mothers housed as members of a sociall mixed sex group

Total protein determinations indicated no significant differences brains of the four groups of animals at 6 months of age Similar neg resulted from water soluble synaptic plasma membrane synaptic co Triton soluble protein determinations Samples from cerebellum and campus were likewise negative

Behaviorally the animals of conditions I II and III showed typic social isolation impairments Bizarre and stereotyped posturings wer with the degree of deprivation

From samples of nonspiny layer IV stellate cells drawn and studi tatively by double blind procedures several significant effects have a visual cortex was not affected The deprived animals showed signific creased branching in S I and in M I The socially deprived but moto riched animals of condition III (which were consistently high in acti the ladders trapeze etc) showed a significantly greater degree of bra S I S II and M I than did all other groups including the mother rea

William T Greenough Mary Kay Floeter Gene P Sackett * Martin J Cheryl Kraff (University of Illinois at Urbana Champaign and *Unive Washington Seattle)

Experience and Macaque Monkey Brain Development Relationship t Isolation Syndrome

It has been proposed that the behavioral primate isolation syndror volve retarded or abnormal maturation of somatosensory cerebellar a development and possibly abnormalities in other sensory motor and gions We have examined the cerebellar flocculus nodulus uvula and lus in monkeys for signs of abnormal development with quantitative :

Golgi cox stained and cresyl violet stained tissue Macaca fascicularis infants were reared for six months from the first week of life in one of three environments total social isolation (I) in a sound attenuating chamber that prevented visual contact with other animals restricted social contact (S) in which monkeys housed individually in adjacent cages were paired for four hours per day or a colony environment (C) containing adult juvenile and infant monkeys in a large cage with various play objects Systematic individual and social behavior measures were made two to four times per week during rearing of groups S and I and social behavior of all groups was studied between 6 and 8 months of age At 8 months the brain were prepared for anatomic examination Behavioral analyses showed isolation syndrome characteristics (stereotyped behaviors ab normal postures social incompetence etc) present at high levels in most I mon keys and infrequent in S and C monkeys Anatomic analyses showed significantly greater Purkinje cell spiny branchlet size in C monkeys and no differences be tween S and I groups in parafluocculus and nodulus There were no differences in granule cell dendritic branching In the uvula and nodulus Purkinje cell body size was greater in group C relative to S and I Further analyses of cerebellar and forebrain regions and comparison with behavioral measures within subjects are in progress

A. J Berman (Brooklyn Jewish Medical Center, Brooklyn New York)

Effects of Cerebellar Decortication Upon Violent and Stereotypical Behaviors in Isolation Reared Monkeys Film Studies

ABSTRACT MISSING

Robert G Heath (Tulane University School of Medicine New Orleans)

Brain Mechanisms in Violent Aggressive Behavior Rationale for and Results of Treatment by Cerebellar Stimulation

This paper presents a demonstration with reporting depth electrode patients of correlations between deep brain activity and violent aggressive behavior and a demonstration on the basis of anatomic data that there are direct connections between the sites where brain activity correlates with violence and sensory relay and nuclei containing cell reservoirs for chemical transmitters an interrelated system that is an important component of the neural network for emotional ex pression

Experimentation with unit recordings in animals also demonstrates functional relationships within this system particularly as to the effects of cerebellar stimu lation

Results obtained by application of cerebellar stimulation to violent patients are also reported

Bernard Saltzberg (Texas Research Institute for Mental Sciences Houston)

Noninvasive Methods for the Detection of Abnormal Deep-Brain Electrical Activity

Intermittent deep-brain electrical spiking activity has been implicated in c tain brain and behavioral disorders such as epilepsy and uncontrolled violent gressive behavior This paper reports on the development of methods for det ing intermittent complex EEG patterns that are time locked to these abnorm deep brain electrical spiking events

Studies in monkeys with deep brain implants have demonstrated that the times of occurrence of particular patterns of scalp EEG activity are highly co lated with the times of occurrence of deep brain electrical spikes In separate studies conducted by R G Heath and A J Berman such spiking activity pro to be characteristic of monkeys that were raised in isolation a condition that produced highly aggressive and violent behavior in these nonhuman primates. view of the results of such invasive studies in monkeys the approach to the de tection problem for noninvasive human studies is based on the postulate that deep brain electrical spiking is reflected in the EEG as a sequence of complex transient patterns that are time locked to depth spikes The individual transie patterns to be detected may differ in amplitude and interval separation but a assumed to be similar in wave shape

Examples of digital filtering approaches as well as spectral deconvolution a proaches are presented as a basis for detecting transient patterns in the EEG from which deep-brain pathology can be inferred The particular detection ap proach selected will depend upon the amount of a priori information available on the times of occurrence of the patterns to be detected as well as on the background EEG activity in which these patterns are embedded The mathe matical model upon which the detection methods are based is discussed in the context of testing hypotheses concerning the presence of deep-brain electrical spiking in the scalp EEG

## SYMPOSIUM TELEVISION AGGRESSION AND CHILD BEHAVIOR KEY DEVELOPMENTAL AND MENTAL HEALTH ISSUES

Chair George V Coelho National Institute of Mental Health Rockville Maryland

Discussant David Pearl National Institute of Mental Health Rockville Maryla

This symposium brings together leading educators developmental psycholo gists and other social scientists to examine new research and policy issues regar

in the role of television in the lives of children and especially its impact on their behavior personality and general psychosocial development

The moderator presented an overview of NIMH continuing concerns and research investments since the Surgeon General s Study Each participant then presented information and perspectives on TV viewing contexts and patterns by reviewing assessing and synthesizing the relevant body of TV research about children in adolescence in their respective areas of concern Special attention will be paid to ecological factors such as family environment peer group setting and interaction situation In addition personality cognitive and age/developmental factors in prosocial as well as antisocial aggressive behavior in children who are exposed to different TV programs in different cultural and institutional settings were discussed As far as possible each participant also focused on results that aid in our understanding of mediating processes and mitigating variables related to viewing habits and preferences of preschool children elementary school children and adolescents through age 18

Concluding commentary and general discussion was planned so as to place emphasis on new directions in research strategy theory and methodology measurement of learning variables etc and on emerging public concerns in education and broadcasting designed for children

Tannis MacBeth Williams (University of British Columbia Vancouver)

Differential Impacts of TV on Children A Natural Experiment in Communities With and Without TV

A longitudinal study of the impact of the inception of television was conducted in three Canadian communities This research was carried out by several faculty members and graduate students in the Department of Psychology at the University of British Columbia under the direction of Tannis MacBeth Williams.

The focus of the project was on a town given the pseudonym Notel which first obtained television reception (one channel the Canadian-government-owned CBC) in November 1973 Two other towns were chosen for comparison Unitel and Multitel All three towns were studied just before Notel received television reception and again two years later During both phases of the research Unitel had CBC reception and Multitel received CBC and the three major US networks (ABC CBS NBC)

Th project included assessments of the impact of television on children s aggressive behavior reading skills associative fluency (creativity) block design and vocabulary scores sex role perceptions and attitudes and participation in community activities Participation in community activities by adults and problem-solving skills and environmental perceptions of adults, were also examined

The emphasis of the paper presented in this symposium is on the findings concerning the impact of television on children s aggressive behavior This research was done by L.A Joy M M Kimball and M L Zabrack Their work included observation of verbal and physical incidents of aggression during free play on the school playgrounds Five male and five female children in each of the *three towns in each of grades 1 2 4 and 5 were observed before Notel got tele*vision and in each of grades 1 2 3 and 4 two years later Children observed during the first phase of the study were observed again in the second phase if available Each child was observed by two trained observers during 21 one-minute intervals over a period of 7–10 days Reliability was greater than 0 8 in both phases of the study In addition teacher ratings and peer ratings of aggressive behavior were obtained for all children in the grades included in the observational study

The longitudinal study of the 44 children observed both before and after Notel children got television revealed significant increases in both verbal and physical aggression for Notel but not the other two towns Before Notel had television reception there were no town differences in physical aggression Multitel children were more verbally aggressive than Unitel children Notel and Unitel children did not differ in verbal aggression Two years after their town received television the same Notel children were significantly higher in both verbal and physical aggression than their peers in the other two towns Boys were more physically aggressive than girls

The cross sectional study of 240 children in the three towns during the two phases of the study revealed that children in Notel were physically more aggressive than their Unitel peers but not different from Multitel children On the average children were more physically aggressive during the second phase of the study and males were more aggressive than females In verbal aggression during the first phase Multitel children were higher than children in the other two towns and *the latter did not differ significantly Only Notel children increased* significantly in verbal aggression between the first and the second phase of the study In the second phase Notel children were more verbally aggressive than children in Multitel who were in turn more aggressive than children in Unitel No age differences in aggression were found in the cross sectional analyses This suggests that differences between the first and second phases obtained in the longitudinal study were not due to developmental change

In both phases of the study the teacher and peer ratings were intercorrelated and were also correlated with the observational measures of aggression lending validity to those observations

The findings were discussed in terms of the general role played by television in children s socialization and in terms of the theoretical models concerning the impact of television on the acquisition and performance of aggressive behavior

Eli A Rubinstein (State University of New York Stony Brook)

Involuntary Subliminal TV Intoxication Some Clinical Issues

Research on the effects of TV violence on the behavior of young viewers has primarily concentrated on normal populations Very little research has been published on such effects with special pouplations such as children institutionalized for disturbed behavior The pertinence of the latter area of research was highlighted by a recent legal effort to defend an adolescent boy in Florida — who was acknowledged to have murdered an elderly woman — on the premise that he suffered temporary insanity due to involuntary subliminal television intoxication " The defense was not upheld because there is no scientific evidence to support such a premise

This paper describes initial efforts to explore television viewing of institutionalized disturbed children and adults Findings suggest that television viewing has differential effects on different subgroups of patients A field study to explore this question further will be described The implications for utilizing recreational television viewing as a therapeutic tool will be discussed Furthermore it will be argued that a study of the effects of television viewing with this population of institutionalized children will provide information relevant to an examination of the role of television in other institutional settings (eg homes for the aged prisons detention centers)

Albert R. Hollenbeck (National Institute of Mental Health Bethesda Maryland)
and Elizabeth J Susman (Pennsylvania State University University Park)

Television and Violence Methodological Issues for Future Research

Current evidence relating the viewing of media violence to the performance of violent acts is stronger than perhaps evidence in any other area of psychology Generally the results of investigations support the notion that a wide range of children of all ages social class backgrounds and gender perform aggressive acts after viewing violence on television Furthermore children who tend to be more aggressive initially are stimulated to higher levels of aggression after viewing televised violence There are methodological considerations however that limit the usefulness of this information for understanding the behavior of children exposed to media violence in the natural context of the home The purpose of this paper is to identify several of these limitations and to suggest a framework within which future research can be directed toward overcoming those limitations

A majority of past research on the effects of media violence on children has employed a short term cross-sectional approach measuring children s behavior in laboratory settings or in group homes for children The primacy of this approach over others makes the available information regarding the effects of media violence on children deficient in at least two important ways First avail

able evidence is biased against the usual home viewing situation M dia pres nta tions of violence in a research context are presented to children in the unnat ral context of the laboratory rather than the setting where most children are expose to televised and real violence – the home Second the effects of age and co hort the typical marker variables for change are confounded with time of mea surement in the cross sectional design Changes in the effect of exposure to media violence across ages may be documented using cross sectional designs but those changes are impossible to interpret from cross sectional designs alone In sum, research to date has focused on a single exposure or a series of brief exposures to television in a nontypical viewing environment Thus the context and the content of the natural viewing environment and how that influences behavior during the impressionable childhood years are gaps in our understanding of the effects of media violence on childhood socialization

Current trends in developmental psychology indicate that the direction of future research will focus on these two neglected areas One trend is toward a more ecological perspective which includes the child s home This viewpoint considers the home environment as a naturalistic laboratory for experimentation While observing behavior in its natural context we also must attempt to manipu late the environment in order to understand the basis for the observed behavior Television is certainly a manipulatable variable A second trend of developmental psychology is toward a life span perspective of developmental chan e This approach provides a methodological framework in which to examine long term effects of media exposure to violence It would appear that major gaps in our knowledge of the effects of media exposure to violence during childhood years can be corrected through studies which incorporate either or both of these per spectives

SYMPOSIUM THE BIOLOGY OF AGGRESSION

Chair John Paul Scott Bowling Green State University Bowling Green Ohio

Discussant Paul MacLean National Institute of Mental Health Bethesda Maryland

Robert J Blanchard D Caroline Blanchard and Lorey K Takahashi (University of Hawaii at Manoa Honolulu)

Pain and Aggression in the Rat

The hypothesis that pain produces aggression was examined by comparison of behaviors in an established rat colony (for dominant colony males and strange in truders) to those seen in reflexive fighting and in a tube test involving tail shock During reflexive fighting dominant colony rats switched abruptly from the attack

pattern displayed in the colony to show activities (boxing freezing) typical of colony intruders in either task Moreover forelimb movements similar to the "strikes" seen in reflexive fighting could be obtained during foot shock to rats held alone on the grid Finally bites to an anesthetized conspecific were potentiated by foot shock or tail shock but only when the snout (rather than other body sites) could be bitten Such snout bites are typical of colony intruders and not of attacking colony rats

When male and female rats behaviors were compared in the tube test male biting and wounding of the snout of an anesthetized male conspecific was a direct function of the intensity of tail shock the number of bites declining systematically in the time interval after shock Female rats biting of male rats was also dependent on shock but did not produce wounds

However when an anesthetized cat was presented in the same situation females bit and wounded the cat even before shock was given while the males again bit only in response to shock These data were interpreted as indicating that male biting of both a conspecific and a predator fits the same defensive biting pattern In contrast female biting of a male rat is actively inhibited while female biting of a predator is neither inhibited nor shock dependent The latter finding may reflect the adaptive value (protection of the young) of attacking a predator before it actually hurts the female rat

All of these data suggest that the defensive biting pattern elicited by pain or by the proximity of a predator (when the subject is restrained) differs in every detail from the activities typical of a dominant colony rat attacking colony intruders There is excellent agreement however between pain-elicited behaviors and the defensive activities of colony intruders suggesting that pain produces not aggressive but defensive behavior

Klaus A Miczek (Carnegie Mellon University Pittsburgh)

Drug Effects on Attack Threat Defense and Submission in Laboratory Rats

Sequences of agonistic interactions between two rats were generated by three procedures 1) omission of food reinforcement in a runway situation 2) intrusion by a rat into the homecage of selected isolated and food-deprived rats and 3) intrusion by a rat into a colony of rats with an alpha animal The topography of fighting was similar in all three situations (16-mm film) and included all major components of attack threat defense submission and flight Frequency duration and temporal pattern of salient behavioral elements constituting fighting behavior were measured by two observers actuating keyboards Drugs were administered to either dominant or subordinate opponents via IP or IM route 14–45 minutes before test Administration of low doses of d amphetamine (0 063–0 1 mg/kg) chlordiazepoxide (5 mg/kg) alcohol (0 5 gm/kg) and L-DOPA (10 mg/kg) increased the frequency of attacks and threats toward intruder rats Intermediate doses of these drugs suppressed attack and threat behavior without affecting lo-

comomotor activity In contrast to these biphasic drugs effects ~⁹ tetrahydroca binol (THC 0 125–4 mg/kg) and cocaine (0 5–32 mg/kg) failed to enharce a behavior over a wide dose range THC selectively suppressed attacks at very l doses However when amphetamine L DOPA alcohol or THC were adminis to the intruder or subordinate animal considerably higher doses were necessa to alter the reaction of defense submission and flight than those affectir th attack pattern Nondrugged resident dominant rats altered their behavior as a function of the opponent s drug state amphetamine L DOPA alcohol and treated intruder rats were attacked and injured more often than placebo-treate rats Pharmacologic manipulations differentiate between an attack threat patt and a defensive submissive pattern

David B Adams (Wesleyan University Middletown Connecticut)

Brain Mechanisms of Offense Defense and Submission

A progress report is offered on a long term project to map out the neural ci cuitry underlying aggressive behavior in mammals The project began with sin l neuron recording in the midbrain central gray and ventromedial hypothalamus the cat during affective defense behavior It was developed further by ethologic and lesion studies on intraspecific aggressive behavior of muroid rodents, espe ially the laboratory rat The present report attempts to synthesize these two a pproaches and offers a working model of neural circuitry for both cat and mur rodents

Ethological studies on muroid rodents have suggested that aggressive behavio may be organized around three motivational mechanisms offense defense (equivalent of affective defense in the cat) and submission These motivational mechanisms it is hypothesized consist of homogeneous pools of neurons that are activated by motivating stimuli and/or hormones Each motivational mec anism when active then activates its own peculiar set of motor patterning mech anisms which produce measurable or observable motor patterns in the presence of appropriate releasing and directing stimuli

The motivational mechanism of offense in muroid rodents has not been locat It may be activated by motivating stimuli which include unfamiliar conspe ific odors (processed perhaps in the basolateral amygdala) and— in males only – by testosterone-dependent pheromones (processed perhaps by the olfactory tubercle) It is also activated during competitive fighting which may be mediated by the amygdala The motor patterning mechanism of offense includes approach bite and kick attack (directed to the flank of the opponent) offensive s deways posture offensive upright posture and various threat patterns

The motivational mechanism of defense is apparently located in the midbrain central gray of both cats and muroid rodents It may be activated by many types of motivating stimuli which include pain (via the paleospinothalamic pathway), sudden auditory stimuli (via the lateral lemniscus but not requiring the inferior

colliculus) and large moving visual stimuli (perhaps via the pretectum). Defense may also be activated via forebrain circuits that traverse the perifornical hypothalamus, but the forebrain is not necessary for defense behavior. The motor patterning mechanism activated by defense in muroid rodents includes freezing, flight, defensive upright posture, threat patterns, and – characteristically – a lunge and bite attack directed at the face of the opponent. Defense is rarely observed in laboratory animals, but is commonly seen in wild animals during maternal nest defense, and in laboratory animals following olfactory or forebrain lesions.

The motivational mechanism of submission is apparently located in the midbrain central gray. It may be activated by the same motivating stimuli as those of defense. Its motor patterns in muroid rodents include freezing, flight, defensive upright posture, full submissive posture, threat patterns, ultrasound, but *not* lunge and bite attack. Submission is often observed in laboratory animals that are attacked.

The forebrain, it is suggested, switches an animal from defense to submission in the presence of familiar consociate (conspecific, laboratory technician, etc.) stimuli. More specifically, it is suggested that the neural circuitry of the ventromedial hypothalamus is a logical "and gate" switch that is activated by the confluence of amygdala and septal inputs (representing familiar consociate stimuli) and midbrain central gray input (representing defense inputs) and that it inhibits the defense motivational mechanism and facilitates the submission motivational mechanism.

J. M. Koolhaas (State University of Groningen, The Netherlands)
The Hypothalamus and Types of Aggressive Behavior in the Rat

Aggressive behavior of male rats can be observed in a variety of situations and seems to serve a variety of goals. The experiments presented indicate that different types of aggressive behavior are not only elicited by different external stimuli, but are also based on different internal mechanisms.

Electrical stimulation of the lateral hypothalamus (LH) elicits either of two types of aggressive behavior in the presence of a male conspecific. One type closely resembles behavior performed in a territorial situation characterized by fighting and several threatening postures and a strong orientation of the behavior towards the opponent. In the second type these threatening postures are rare, the stimulated animal just wanders about, fighting only when it happens to meet the opponent. This behavior may be described as reactive fighting. The data suggest a slightly different electrode localization for these two types of aggressive behavior.

Lesions in the ventromedial hypothalamus (VMH) can facilitate either of these types of intraspecific aggressive behavior, depending on the exact location of the lesion. Posterior VMH lesions facilitate territorial aggressive behavior, whereas anterior VMH lesions increase the tendency to perform reactive fighting.

Both the stimulation and the lesion procedures described here appear to influence the occurrence of aggressive behavior specifically It is concluded that at the level of the VMH and of the LH neural mechanisms seem to exist that underlie either defensive or offensive aspects of aggressive behavior

Alan I Leshner and Kerry E Roche (Bucknell University Lewisburg Pennsylvania)

**ACTH and Vasopressin Treatments Immediately After a Defeat Increase Future Submissiveness**

Earlier studies have suggested that the hormonal responses to defeat can serve behaviorally adaptive functions by feeding back and modifying either ongoing or future agonistic responses These earlier studies have used the technique of preventing hormonal responses and observing behavioral changes subsequent to defeat We report here the results of two studies using the opposite approach These studies examined the effects on future submissiveness of augmenting the usual hormonal responses to defeat by exogeneous hormone treatments

*Mice* were subjected to an initial defeat by an unfamiliar *conspecific* and treated immediately with either ACTH lysine vasopressin or a saline placebo They then were tested for submissiveness at either 24 hours 48 hours or seven days after the initial agonistic experience and hormone treatment Postdefeat treatment with either ACTH or vasopressin increased future submissiveness relative to control although the time courses of the effects of the two hormones were different Postdefeat treatment with ACTH increased submissiveness when measured at 24 and 48 hours after the initial experience but not when measured at seven days On the other hand postdefeat treatment with vasopressin still affected submissiveness when measured at seven days These results are interpreted as supporting the hypothesis that the acute hormonal responses to defeat can feed back and modify future agonistic in this case submissive responses

## SYMPOSIUM FACES OF ANTIVIOLENCE

**Chair John Paddock Institute of Oaxaca Oaxaca Mexico**

Several villages and towns in one arm of the Valley of Oaxaca in southern Mexico have what may be called unnaturally low homicide rates that is their rates are only a fraction of those prevailing in neighboring and outwardly similar communities in the valley as a whole and in the state These low homicide rates appear to reflect a general attitude of repudiation of interpersonal violence and the phenomenon is termed antiviolence

At the 1974 meeting of the International Society for Research on Aggression the idea of antiviolence was presented and some first tentative indications from a pilot study were sketched out Now the researchers concerned are able to flesh out several aspects of the picture In addition the possibility of developing a theory of antiviolence is suggested for while it is not common anywhere it appears in slightly variant forms in a number of widely scattered parts of the world and may therefore be a pan human development whose clarification in the present study may lead to future generalizations

John Paddock (Institute of Oaxaca Studies Oaxaca Mexico)

Introduction The Study as Science

Anthropologists in ISRA are a small minority hence some explanation of our methods may be helpful

First in the matter of the place of anthropology within science some including a few anthropologists think anthropology belongs in the humanities not the sciences This may be especially true for psychological social and cultural anthropology in which areas most of our work occurs

Next in regard to science and violence the question arises Is the scientific study of violence possible? Looking at several of the most distinguished post 1967 books on violence we seem to see a trend toward increasingly scientific analyses

Finally as to anthropology and antiviolence one might ask why we resort so little to such protective devices as questionnaires and tests and so much to observation of antiviolent human beings as they go about their usual activities even though this means we are subject to constant accusations of being unscientific The argument oversimplified is this No amount of laboratory observation and experiment plus statistical manipulation can produce the information that one obtains by watching the human animal behave in its own habitat the approaches are complementary

Rose Wax Hauer (Institute of Oaxaca Studies Oaxaca Mexico)

A Psychodynamic Face Learning to Be Violent Vs Learning to Be Antiviolent

Sentence completion tests were given to all fifth and sixth grade children in ?0 Valley of Oaxaca communities which differ in their frequency of violence (or degree of antiviolence) but share a Zapotec Indian culture Responses from one violence prone town were highly revealing of underlying dynamics Those relating to the present theme are analyzed and compared with responses from an antiviolent town of similar size

The tests show marked differences in images of self and of adults in male female relations in intensity of emotion expressed and in attitudes toward authority Contrasts in child rearing are plainly reflected The violence prone town shows conditional love parental inconsistency and arbitrariness and greater use of pun

ishment The contrasting responses serve to illuminate the psychodynamics of *machismo* Additionally they show that the lesser degree of *machismo* of the antiviolent town appears to be related to greater possibility for ego development in Jane Loevinger s terms

Responses show that in the violence prone town there is an alternate pattern that places a high value on individual achievement In the antiviolent town by contrast responses indicate that the good of the group and conformity to its demands are more highly valued respect for authority there involves more cooperation and reciprocity

Margaret L Sumner (Institute of Oaxaca Studies Oaxaca Mexico)

A Social Face Social Structure and Control in an Antiviolent Village

As the other papers imply one necessary condition for maintenance of an antiviolent community as such is the development of persons characterized by conceptions and feelings and habits that lead to antiviolent behavior Another necessary condition is a type or types of social structure and social control that induce and reward such behavior

Traits characteristic of antiviolent San Francisco appear also in San Juan a village where I have done research for three years Here I indicate some ways in which a positive self image a low intensity of affect and little preoccupation with feelings a reciprocal concept of authority and a low development of male anxiety and need to prove one s maleness enter into role definition and performance in San Juan polity family and child development

Since male violence is considered far more threatening than female violence emphasis falls on the roles of men as citizens husbands and fathers The personality re sources listed here maintain and are fostered by the key civic values of village unity solidarity and integrity and individuals are constrained to conformity with group norms by sensitivity to public sentiment through seeking the desirable esteem and cooperation of others while maneuvering to avoid their much feared ill will

E Paul Morrissy (St Thomas University Fredericton New Brunswick Canada)

A Governmental Face Formal and Real Mechanisms of Conflict Resolution in an Antiviolent Town

San Francisco a peasant town of around 5 000 inhabitants is characterized by (among other things) a strikingly low homicide rate A study of town government suggests a model of interlocking domains in social control coming together in a system notable for diffusion and low intensity of human interrelationships Thus whereas the domains and their sociopolitical functions are similar in San Francisco and in its violence prone neighbors in San Francisco there are mechanisms for maintaining a low level of intensity (in Roderic Gorney s sense of the term) and this makes possible maintenance of a nearly homicide free town

Management of conflict was observed typical patterns are noted and an unusual problem is followed through in detail

While comparisons with violence prone towns are still inadequate some proposals are advanced regarding peculiarities of this antiviolent town in the areas of acquiring influential roles the exercise of power access to the political process manipulation of authority and persuading individuals to follow the community s rules when this implies sacrifice of personal interest

Carl W O'Nell (University of Notre Dame Notre Dame Indiana)

An Individual Face Antiviolent Behavior and Some of Its Hypothetical Personality Correlates A Paradox Within an Enigma

After comparison of ecologic demographic and familiar social and cultural factors has failed to explain the striking differences in levels of interpersonal violence among Valley of Oaxaca communities one looks to formal religious and ethical core values but these too appear to differ little if at all (except of course the attitude toward violence itself)

What independent variables then account best for the strong differences of behavior in the area of interpersonal violence? Child rearing practices and childhood experiences appear to be distinctive in the antiviolent communities and one may predict the occurrence of some personality correlates of these factors

Observations over a number of years in one antiviolent community analyzed in the context of social learning theory suggest that two of these hypothetical correlates are strong needs for social compliance which I call social dependency and deep seated dispositions toward hostility

Antiviolent behavior among people who readily generate hostile impulses is paradoxical enough but this paradox exists within an enigma the occurrence of antiviolent communities in circumstances that seem to favor the opposite Nevertheless the paradox can be transformed into an explanation Hostile impulses may generate not only violence but antiviolence as well

Wayne W Kappel (Temple University Philadelphia)

A Biological Face Violent Deaths in an Antiviolent Town s Record of a Century of Life and Death

This anomaly of frequent homicide in an antiviolent community is examined through an analysis of homicides recorded in local civil records

The best predictor of homicide in these recoreds is the degree to which victims or assailants or both are defined as insiders or outsiders in the local structure ie as community members or not People who are locally defined as outsiders contribute overwhelmingly to homicides both as victims and as assailants

In socializing (or resocializing) outsiders many of whom are in migrants strong pressure exists to conform to the values of the local social order and the conditions

Erica Rosenfeld Susan Maloney L. Rowell Huesmann Leonard D Eron Paulette Fischer Vita Musonis and Ann Washington (University of Illinois at Chicago Circle)

*Effect of Fantasy Behaviors and Fantasy Reality Discriminations on the Observational Learning of Aggression*

In recent years a body of evidence has emerged that suggests that a child s perception of media violence as fantasy or reality influences the degree to which the child imitates the observed behaviors Research suggests that there is gre r modeling of aggressive behaviors when the behaviors are labeled as real than where labeled as fantasy that children who can easily distin uish fantasy from reality are less likely to be adversely affected by media violence and that chi dren who are predisposed to high fantasy are less aggressive In a 1972 study Eron Huesmann Lefkowitz and Walder also found that girls perceive TV as less realistic than do boys and model aggressive behavior on TV less However it remains to be demonstrated whether different styles of fantasy relate differ ently to aggression and whether a reduction in modeling of aggressive behavior could be engendered by teaching fantasy reality distinctions The current study was designed to explore these questions

The subjects were 748 boys and girls from the first and third grad s in Oak Park Illinois who were participating in a three year observational study of fac tors affecting the modeling of aggressive behavior Among the measures admin istered to subjects in two 40-minute testing sessions were 1) a peer nominated measure of aggression 2) a measure of how realistic subjects thought various TV programs were 3) a measure of the amount of TV violence watched and 4) a new 45 item fantasy questionnaire called the Imaginal Processes Inventory for Children (IPI-C) By factor analyzing the nine IPI-C scales three styles of fan tasy emerged which were remarkably similar to the adult factors of daydream ing found by Singer and Antrobus in 1972 The fantasy styles are 1) action intellectual fantasy 2) fanciful intense fantasy and 3) negative aggressive fan tasy

A clear positive relation was again found between viewing TV violence and aggression Additional evidence suggests that a child s view of the degree of real ism of television related positively to aggression (particularly for girls) and may act somewhat to mediate the relation between viewing of TV violence and ag gression It is also apparent that for boys negative aggressive fantasy is predic tive of overt aggression while for girls action fantasy and negative aggressive fantasy are predictive

Those children identified as viewers of moderate or high amounts of violence in the first wave of the study were selected for the field experiment and they were randomly divided into an experimental and control group of 100 subjects each A pretest was administered measuring each child s judgment of realism for

specific a gressive behaviors seen on TV The experimental subjects were then exposed to three training sessions at three week intervals in which they watched a five-minute tape of a TV program and then participated in discussions structured to elicit fantasy behaviors fantasy reality discriminations and imaginative play The control group received a similar three sessions in which no fantasy was elicited A posttest of the child s assessment of TV realism was given to each child several weeks after the conclusion of the training procedure

On the whole the realism training produced disappointing results At best it seems that the experimental subjects improved their perception of reality slightly while the control subjects perceptions worsened Nevertheless it was true that the training did have some effect particularly upon those subjects who initially believed TV shows were realistic but had a neutral sex role orientation and did not identify with aggressive TV characters

It is believed that the procedure was not more successful because the effect of training may have been counteracted by the use of aggressive and action fantasy material in the training procedure Aggressive and action fantasy we found in the first part of this study are positively related to aggression in children

L. Rowell Huesmann Paulette Fischer Leonard D Eron Rebecca Mermelstein Esther Kaplan-Shain and Sharon Morikawa (University of Illinois at Chicago Circle)

Children s Sex Role Preference Sex of Television Model and Imitation of Aggressive Behaviors

An important finding in early field studies of aggression and viewing of television violence was that females were less affected by viewing violence than were males In a ten year longitudinal study conducted between 1960 and 1970 Eron Huesman Lefkowitz and Walder found a significant positive relation for boys aggression and television violence viewing but no evidence of such a relation for girls One possible explanation for this lack of modeling effect in girls was the lack of aggressive female models in the medium at that period of time Another possible explanation is the differential reinforcement of aggressive behavior due to differential socialization processes for boys and girls

The current study is an attempt to measure more precisely the effect of sex roles on observational learning of aggressive behaviors The subjects are 748 boys and girls who constitute that part of the first and third grade population of Oak Park Illinois for whom permission could be obtained The subjects are being tested and interviewed in each of three consecutive years In each year a subject s aggressiveness is measured by a peer nomination procedure and measures are obtained of self reported viewing of male violence and female violence on television self reported similarity to television characters and sex role preference The sex role scale allows the subject to select neutral masculine or

feminine items so that a subject is not forced into either a masculine or feminine category

Results from the first year of study indicate that viewing of television violence is significantly positively related to aggression in both boys and girls However while the relation is getting stronger with age for boys it is getting weaker with age for girls Furthermore sex role preference is clearly related to peer rated aggression Peer rated aggression is significantly positively related to a masculine sex role preference for both boys and girls and significantly negatively related to a neutral sex role preference However the sex of the aggressive actor on TV did not differentially affect the modeling of aggression by boys and girls

In general these results seem most consistent with the socialization hypotheses for explaining differences between boys and girls in the observational learning of aggression Girls are generally not reinforced for engaging in overt aggressive acts and the relation between viewing of violence and overt aggression decreases as girls become older The more overtly aggressive girl is one who is *lower on feminine and neutral sex role identification* who is higher on masculine identification and who engages in action oriented fantasies On the other hand as boys become older they are taught that some aggressive behavior is acceptable As a result the relation between viewing of TV violence and aggression becomes clearer as boys become older The more overtly aggressive boy is one who is higher on masculine sex role orientation and who engages in negative aggression fantasies

Charles W Turner and Michael R Fenn (University of Utah Salt Lake City)

Instigating Effects of Associated Retrieval Cues and White Noise on Delayed Verbal Aggression

The present research investigated the delayed behavioral impact of verbally aggressive stimuli which were or were not reinstated from memory via associated retrieval cues A 2 X 2 between subjects factorial design was employed to manipulate intensity of white noise (soft vs loud) for induced arousal and connotation of the verbal material to be recalled (nonaggressive vs aggressive) Sixty two male undergraduates participated in three tasks that introduced the experimental manipulations Subjects first learned 60 paired associates that varied the connotation of the stimuli to be remembered aggressive vs nonaggressive The second task introduced a 15 minute nonrehearsal delay Thereafter subjects ostensibly interacted with a fellow subject by writing exchanging and then evaluating self descriptions as part of a social learning task Prior to evaluating their (nonexistent) partners self-descriptions subjects were aroused by one of two levels of white noise and given retrieval cues to reinstate either the aggressive or nonaggressive words they had previously learned The main measure of verbal aggres-

ion was derived from the written partner evaluations The results indicated that ubjects given aggression associated retrieval cues and simultaneously exposed to oud white noise were si nificantly more verbally a-gressive ($P < 0.01$) than subects in the other three experimental conditions The results support the thesis hat the presence of retrieval cues associated with aggressive stimuli may facili ate a delayed a gressive reaction if subjects are also aroused and disinhibited

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AGGRESSIVE BEHAVIOR
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# Differential Aggressiveness and Litigiousness Social Support and Social Status Hypotheses

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The Qolla Indians have high rates of involvement in agonistic forms of interaction In previous reports the author suggested that ecological and physiological factors are causally associated with intracommunity differential participation in aggressive behavior The present article described tests of hypotheses using other variables to explain this behavioral differentiation The hypothesis that aggressiveness and participation in litigation are a function of the amount of social support the individual can potentially mobilize is tested The relationships between indicators of social status (wealth education age political activities and ritual participation) on the one hand and aggressiveness and litigiousness, on the other also are examined

Key words law and conflict aggressiveness Qolla social status social support litigiousness, Peru

## INTRODUCTION

Over the years the Qolla have acquired a reputation for aggressiveness and hostility Anthropologists and other scholars both foreigners and native Andeans have repeatedly stressed the salience of this dimension of Qolla character and there can be little doubt that interpersonal conflict is pervasive in community life [cf Bolton 1973] However two reservations must be registered with respect to Qolla aggressiveness

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First, this one strand does not constitute the whole cloth of Qolla personality. Without necessarily denying the importance of aggression in Qolla social life, numerous investigators, especially those who have studied Aymara speakers in post-revolutionary Bolivia, have pointed out quite correctly that Qolla conduct is not unidimensional. Carter [1968], for example, writes of "positive balances which permit Qolla (or Aymara) society to function," and Heath [1969, personal communication] suggests that an "amiable side" to the Qolla exists.

Second, as in all societies, among the Qolla individuals vary in their levels of aggressiveness, litigiousness and hostility; they do not participate in equal measure in interpersonal strife and agonistic behavior. The oft-heard Qolla remark, "No somos iguales," certainly applies to aggressiveness. Furthermore, the Qolla recognize and verbalize their awareness of this behavioral diversity. They say that some people are abusive (abusivo) and other people are humble (humilde). The purpose of this paper, then, is to contribute to an understanding of the causes of differentiation in levels of individual aggressiveness and litigiousness within one Qolla community.

The analysis to follow is not the first attack on this problem. In other writings [Bolton 1970, 1973, 1976], it has been argued that part of this behavioral differentiation could be accounted for by biological variations within the Qolla population. More precisely, I tested the hypothesis that there is a relationship between degrees of aggressiveness and differences in the functioning of glucose homeostatic mechanisms. Results supported the hypothesis: aggressive subjects displayed a strong tendency to be moderately hypoglycemic. Nonetheless, when considering the full range of differentiation, hypoglycemia is capable of explaining only part of the variance in aggressiveness and agonistic behavior. What factors are responsible for the remainder of the variance?

Moyer [1971] notes that aggression is not a unitary phenomenon. Rather, there are various kinds of aggression: predatory, fear-induced, irritable, territorial, maternal, and instrumental. Each class of aggression, according to Moyer, has its distinctive physiological basis. Hypoglycemia is one factor in the etiology of "irritable" aggression. It is likely that other biological variables will be found to account for additional portions of the variance in Qolla aggressiveness, testosterone levels, for example, to mention one possibility.

We were forced to explore the biological basis of Qolla aggressiveness by the seemingly irrational nature of this behavior. Instead of being goal-oriented and calculated to bring economic or social benefits to the aggressor, most acts of aggression that came to our attention appeared to be expressive and spontaneous. But the question must be asked: To what extent is Qolla agonistic behavior instrumental? Instrumental aggression does occur, to be sure – e.g., cases of fighting over land, of utilitarian stealing, and of failing to pay debts. If instrumental aggression is important among the Qolla, then one should expect to find a series of social factors associated with the differentiation in individual aggressiveness and litig

ress such factors may either lead an individual to be aggressive or enter into his calculations of the likelihood of success of agonistic behavior There should be positive relationships between the levels of aggressiveness and litigiousness of an individual and the amount of social support which he is capable of mobilizing and an association between socioeconomic status and aggressiveness. These relationships are analyzed below after some essential background information is presented

## THE ETHNOGRAPHIC SETTING

The Qolla inhabit the Lake Titicaca basin in the border region of Peru and Bolivia at an altitude of approximately 3 800 meters and above Although the Qolla numbering more than one and one half million are divided between Quechua speakers and Aymara speakers Qolla culture is fairly homogeneous and set off from surrounding Andean cultures by a set of traits which includes such items as the presence of a dispersed settlement pattern and the absence of maize as an important staple crop

While most Qolla are small scale subsistence farmers at higher altitudes one finds communities of alpaca and llama herders The research reported in this paper was carried out in the village of Incawatana on the Peruvian shore of Lake Titicaca in the Quechua speaking zone * The staple crop for the campesinos of Incawatana is potatoes This item is supplemented with broad beans peas barley oats quinua oca and some minor cultigens produced in small quantities. The limited availability of pastures and totora reed beds keeps animal husbandry at a minimum in this community although each household manages to raise a few animals cattle sheep pigs and guinea pigs principally Additional income is generated through part time activities such as fishing craft production and seasonal migration and employment as burden-carriers and construction workers in urban centers of the region and along the Pacific coast

The basic social unit in Incawatana is the household The Qolla are monogamous and the preferred domestic group is the nuclear family A large percentage of households in Incawatana nonetheless contain one or more aggregated individuals – eg son in law daughter in law grandchild or an aged parent of one of the spouses The 1 200 residents of Incawatana form 230 households

Although descent is reckoned patrilineally [Bolton 1977] for most purposes the bilateral network of kinsmen for all adults in a household provides the basis for significant links to other households Ritual kinship bonds established through baptism haircutting and marriage create further links to other households (see below) Peasants in Incawatana own their land an average of one hectare per household Inheritance is bilateral and property is divided equally among siblings male and female

*The names of villages and persons are pseudonymous for obvious reasons

Incawatana is a parcialidad or free community no hacienda exists within or adjacent to the community Almost all land is owned by residents of Incawatana. The village occupies the lowest position in the national governmental system. The authorities within Incawatana are appointed by the various officials in the district capital Qochapata sometimes upon recommendation by the outgoing authority or the assembly of community members The most prominent authorities in the village the tenientes politicos are responsible to the district governor for the maintenance of peace and order within their jurisdiction (Bolton and Bolton 1975)

## THE DATA

My assistants and I lived and worked in Incawatana for two years (November 1968 to December 1970) During this period we gathered observational material copied archival records and conducted both formal and informal interviews. We paid special attention to the topics of interpersonal conflict and aggression developing a file of more than 800 cases of strife which had been handled by the village or district remedy agents In the second half of 1969 we carried out a comprehensive census and genealogical investigation interviewing all but about ten household heads

In order to concentrate more intensively on a segment of this universe we chose a sample of 125 adult males These men selected randomly within each of the village s seven sectors were visited and interviewed at least once each month When physiological data were obtained for various reasons only 66 men from the original sample were utilized (eg some subjects were absent from the village at the time) For the present analysis this reduced sample is employed because we lack information on some variables for the complete sample

The dependent variables aggressiveness and litigiousness have been operationalized as follows First three key informants ranked the 66 men in the reduced sample with respect to aggressiveness Each key informant performed this task twice The rankings of one informant were not included in the overall ranking since the correlation of his first and second lists was unacceptably low and neither of his lists correlated satisfactorily with the rankings done by the other key informants The latter informants on the other hand performed better Their rating–rerating correlations were 0 92 and 0 78 and the average correlation of their four rankings was 0 76 which is satisfactory for this indicator of aggressiveness

The second variable involves the frequency of participation in conflicts brought to the attention of public remedy agents. Through examination of the cases in our file we have calculated the extent of conflict participation for each individual in the sample during the ten year period preceding our field work Complainant or plantiff (demandante) status and defendant (demandado) status are examined separately and in combination

The independent variables social support and social status have been operationalized as follows Information on the size of an individual s potential social support set (to be defined below) is taken directly from the census and genealogical inquiry In some instances we have corrected inaccurate self reports with information obtained informally or from the censuses of kinsmen Unfortunately we have not been able to complete the complex task of verifying self reports on ritual kin sets and we suspect that this information is incomplete especially with respect to the number of times the subject has served as godfather (padrinu) for the children of others Yet we have no reason to think that this incompleteness is associated differentially with levels of aggressiveness

Measurements for three indicators of social status (age education and participation in communal rituals and political affairs) have been derived from the census Wealth has been operationalized in two forms 1) self reports on ownership of livestock and 2) intra sector rankings of subjects performed by two key informants Finally birth order data are taken from the genealogical inquiry

## AGONISTIC DIVERSITY

Key informants appeared to experience no difficulty in ranking the 66 subjects on their ag ressiveness And when we add the scores obtained by each individual on the four rankings we discover that the informants have utilized almost the entire potential range of differentiation That is technically the scores could range from 4 points (highly aggressive) through 264 points (nonaggressive) the actual scores started at 7 points and ended at 263 points Reputations for aggressiveness then can be seen to vary tremendously

This differentiation is visible also in the rates of participation in litigation Table I contains litigation data for 64 subjects for a period of approximately ten years Only one subject participated in no litigation during this period according to our records while one individual was a plaintiff or defendant in 21 cases As plaintiffs the subjects in our sample participated in — indeed initiated — a mean of 3 47 cases (mode = 6 median = 3 and range = 0–10 cases) As defendants the subjects were involved in 3 97 cases on the average (Here the mode is three cases and the median too is three cases ) The defendant range is from no case through 15 cases *

There exists a significant association between the rates of participation as plaintiff and rates of participation as defendant ($r_s = 0\ 69$ $P < 0\ 02$) Although exceptions are found (for example the villager who was a plaintiff in ten cases and a defendant in only two cases or the man who was a defendant in five cases but who never carried a complaint to the authorities) for the most part individuals highly involved in litigation tend to operate both as plaintiff and defendant Some campesinos on the other hand manage to stay almost entirely clear of judicial involvements in any form

*To save space I do not include here detailed tables giving the results of all statistical tests Unless indicated otherwise in the text all chi square analyses utilize cutting points as close

TABLE I Rates of Participation in Litigation

| Number of cases | Number of subjects in sample | | |
|---|---|---|---|
| | Plaintiff status | Defendant status | Total litigatio |
| 0 | 9 | 7 | 1 |
| 1 | 8 | 9 | 5 |
| 2 | 8 | 7 | 5 |
| 3 | 9 | 11 | 5 |
| 4 | 7 | 7 | 6 |
| 5 | 6 | 5 | 5 |
| 6 | 10 | 6 | 4 |
| 7 | 5 | 4 | 4 |
| 8 | 1 | 3 | 3 |
| 9 | 0 | 1 | 5 |
| 10 | 1 | 2 | 3 |
| 11 | 0 | 0 | 3 |
| 12 | 0 | 0 | 5 |
| 13 | 0 | 1 | 4 |
| 14 | 0 | 0 | 7 |
| 15 | 0 | 1 | 0 |
| 16 | 0 | 0 | 1 |
| 17 | 0 | 0 | 1 |
| 18 | 0 | 0 | 0 |
| 19 | 0 | 0 | 1 |
| 20 | 0 | 0 | 0 |
| 21 | 0 | 0 | 1 |

Perhaps the best technique for illustrating agonistic diversity in Incawatana and the range of intracommunity differentiation on aggressiveness is through the presentation of examples of abusive and of humble men and their behavior First let us examine an example of a man considered abusive Andres Quispe the individual with the highest rate of litigation What were the acts which caused don Andres to spend so much time in the offices of the various village and district authorities? A sketch of his legal problems follows

### An Abusive Man Andres Quispe

Over a 10 year period Andres was a principal figure in some 20 lawsuits most of them directed against him He was called before the village authorities to answer such charges as the following

1) sexually abusing his sister in law (April 1960)
2) inflicting a wound on a fellow villager (June 1960)

3) insulting and beating up his wife (December 1961)
4) violently threatening his wife (January 1963)
5) wounding an uncle in a brawl (July 1963)
6) failing to pay a debt (November 1964)
7) punching and kicking an aunt (July 1965)
8) attempting to rape a neighbor s wife (September 1967)
9) entering the compound of another aunt with the intention of stealing (February 1968)
10) insulting a fellow villager (December 1968)
11) insulting injuring and stealing from an uncle (February 1969)
12) fighting with a woman he was trying to seduce (September 1969)
13) threatening to kill his third wife (September 1970)
14) attacking and injuring his father (September 970)

In a few cases Andres was the plaintiff too charging others with having insulted and defamed him having wounded him in fights or having menaced his life

Our information on a series of other problems which Andres has had is incomplete It is said that he has had troubles with some neighbors over land but we do not have adequate documentation of this conflict However as a consequence of the situation Andres is reported to have cried (a means of gaining supernatural pity and favorable intervention) and cursed his neighbor causing his premature death Andrés s third wife has repeatedly consulted with district judicial authorities about the possibility of obtaining a divorce but they tell her You are married you cannot get divorced Your husband could kill you but you cannot separate because you are married Some years earlier Andres had a disagreement with one of his uncles To obtain vengeance Andres stole the uncle s cow and tried to kill it but it did not die Instead it was found alive but bloody from wounds he had managed to inflict There are gaps in our chronological record These gaps are not due to periods of peacefulness they correspond largely to times when Andres was absent from the community – ie in Arequipa working

By Incawatana standards Andres is an abusive man although not necessarily the most abusive man in the village despite his extensive case record His violence has had limits he has not been implicated in homicide while numerous co villagers have been involved in that type of extreme aggression But Andres moves from conflict to conflict engaging in disputes with kinsmen spouses neighbors and unrelated villagers His behavior is not atypical

## Humble Men Some Examples

Humble men are characterized by their low levels of participation in conflict and this fact makes it more difficult to discuss them However some brief comments about several humble men are in order

In Table I one notes that one individual had participated in not a sing of litigation Several factors permit us to understand his non involvement he spends at least half the year living outside Incawatana returning to th munity primarily to plant his fields and harvest them Second this man l Belizario is an outsider (forasteru) born in a neighboring district and ma Incawatana Even decades of living in a Qolla community do not erase th edge that an individual is a forasteru

Manuel and other humble men are not immune from provocations by aggressive co villagers Manuel for example has been the victim of thieve than one occasion In one instance visitors to his house walked off with h personal papers and documents His response was to inquire calmly of thc had been to his house whether they had accidentally taken his papers had of course Many years before too someone had entered his house wl was absent stealing a poncho a carrying cloth potatoes and some housel utensils Manuel is certain that the thieves were kinsmen but he did not su cause he lacked proof Nor did he engage in acts designed to bring about d intervention because the value of his loss was not too high Moreover he s would be too much bother to be running around suing and entering into w conflicts Manuel is a gentleman in Incawatana terms a kaballeru mild m and patient neither quick to offend others nor readily provoked by the of of others

A second example of a humble man is Pablo Pacompia a man in his r forties and only a few years older than the abusive Andrés Quispe For Pab records show only one case of litigation and Pablo was the plaintiff A neig one of the most abusive men in the village with a reputation for being a tr killer had entered Pablo s corral at night and had slaughtered Pablo s cow approximately 1 100 soles Pablo sued and recovered 130 soles in damages neighbor had reacted violently as a result of a minor disagreement between two men

A third example of a humble man though not quite as humble as the two is Antonio Parillo who has been involved in some litigation as follows

1) He was sued for having captured a girl with whom he was having an the matter ended in marriage

2) He was one of seven members of a band accused of stealing the moutl of an instrument belonging to one member of the band

3) He was called to defend his wife who was accused of stealing a neighb chicken

4) He was sued by his brother in law for having gotten into a fight with h a trivial matter while both were drunk

Antonio has had no other serious conflicts or lawsuits However at the tu our field work was drawing to a close a bit of trouble was brewing for Anto

His neighbor Cecilio Acuna (the same man as in Pablo Pacompia s case the cow killer and reputed three time human murderer) had begun to molest Antonio Once while inebriated Cecilio had gone to Antonio s house and challenged him to a fi ht Antonio who was sober declined When sober he told us one must restrain oneself and not react emotionally to provocations Trouble between Cecilio and Antonio seems to have developed because of a joking incident in which Antonio accidentally ripped the seam threads on Cecilio s poncho Now Cecilio threatens to kill Antonio and he has challenged him to fight on several occasions Antonio s response? And so now he has two offenses with me On the third I shall sue him probably before the authorities in Incawatana to force him to give me a guarantee of safety and to obligate him to stop offending me He enters right to my house He is an assassin and surely he wants to do to me what he did to the others He is crazy

When asked why he had not been involved in more lawsuits Antonio replied 'One must be humble One must not be a tough (macho) or anything One should be humble One loses money when one gets caught up in lawsuits and one loses time as well Antonio s attitude is probably representative of the attitudes of the humble in Incawatana

## THE ABUSIVE VERSUS THE HUMBLE

The humble or nonaggressive men engage in fewer cases of litigation than do the abusive or aggressive ones ($\bar{x} = 5\ 6$ vs 8 3 cases respectively $x^2 = 8\ 48$ $P < 0\ 01$ $df = 1$ $n = 53$) Indeed when one contrasts the highest with the lowest quartiles on the dimension of aggressiveness the differences in litigation involvement are even more pronounced (as plaintiff $\bar{x} = 4\ 4$ vs 2 5 cases as defendant $\bar{x} = 6\ 8$ vs 1 9 total litigation $\bar{x} = 11\ 2$ vs 4 4)

When one reviews the case histories of humble and abusive men and compares them one finds a more basic difference than mere frequency of litigation That difference is in the readiness to resort to violence

### Abusive Men Are Violent Men

Generally we find that humble men are drawn into conflict against their will by the actions of abusive ones While we pointed out above that there is a positive association between rates of litigation as plaintiff and rates of litigation as defendant another pattern must be mentioned The abusive men those high in aggression tend to be involved in litigation more as defendants than as plaintiffs and the humble men tend to be involved more as plaintiffs than as defendants The abusives men high in aggressiveness are more likely to have a high ratio of defendant to plaintiff status than are humble men those low in aggressiveness ($x^2 = 7\ 99$ $P <$ 0 01 $df = 1$ $n = 53$) Humble men do not cause trouble although sometimes they must react to the aggressiveness of others When they react they are more likely to depend on strategy (litigation) than on physical skill (violence)

Let us turn next to some hypotheses that might help us to understand causes of agonistic differentiation in Incawatana

## SOCIAL SUPPORT AGGRESSION AND LITIGATION

In 1960 van Velzen and van Wetering showed an association between t relative peacefulness of a society and the presence or absence of fraternal i groups They hypothesized that aggressiveness is produced by groups of rel males pursuing their interests through conflict Otterbein and Otterbein [1 1473] later confirmed the hypothesis that societies with fraternal interest are more likely to have feuding than societies without fraternal interest gro *An intracultural test of the van Velzen and van Wetering hypothesis is poss* if the hypothesis is modified slightly

The basis hypothesis which I set out to test is as follows the larger the s support set available to an individual the more aggressive he will be That i conflict and aggression in Qolla society are instrumental rather than expres *individuals with access to help (either in violent encounters or in litigation)* be more willing to engage in acts of aggression

The social support set in Qolla society attaches to the household and co *primarily of the following categories of kinsmen and ritual kinsmen* in relat to each adult member of the household parents siblings and their spouses parents siblings and their spouses compadres and comadres godparents gc children sons and daughters and sons and daughters in law Comparing the of social support sets is a rather complex task which can be simplified only making certain assumptions In a manner similar to domestic groups and in ordination with individual life cycles social support sets undergo a developr cycle As an individual ages the size and composition of his or her social su set change Households regularly add to their social support set through the establishment of ritual kin ties throu h birth and through marriage At the s time they lose members of the set largely through death The process is illus in Figure 1 The composition of the social support set of an old man is qu t ferent from the composition of the social support set of a young man The fi no longer has available his parents and godparents he may have fewer livin brothers and sisters (especially if he is a younger member of a sibling set) bu will undoubtedly have numerous adult sons and daughters sons in law and daughters in law and godchildren and compadres *A young man* on the othe *hand* is likely to have his parents and parents in law his siblings and th ir spo and his godparents But he will have few godchildren no adult children or chi in law and few compadres

Thus the age of the subject is a pertinent factor that enters into our calcula especially since our subjects ranged from their early twenties to eighty-odd ye When necessary therefore in our analyses we shall control for age In parti ul

| | Categories of Kin and Ritual Kin Supporters | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age | Parents | Hair cutting and baptismal god parents | Uncles and aunts | Siblings | Offspring | Marriage god parents | Compadres | God children |
| 20 | + | + | + | + | ± | – | – | – |
| 30 | ± | ± | ± | + | + | + | ± | ± |
| 40 | – | – | – | ± | + | ± | + | + |
| 50 | – | – | – | ± | + | – | + | + |
| 60 | – | – | – | ± | + | – | ± | + |
| 70 | – | – | – | – | ± | – | – | ± |

Fig 1 Changes in Qolla social support sets during their developmental cycle (+ = present – = absent)

this must be done when using the aggressiveness variable since there is an association between age and aggressiveness (see below) The following tests deal with the size of particular segments of social support sets and with their total size We assume that a relationship exists between the size of action sets (ie those actually mobilized) and the size of the pool from which individuals can be recruited for action sets The success of recruitment efforts may vary in relation to a number of factors which have been presented by Gulliver [1971 19–20]

Which members of his kin-set an individual can recruit perhaps in conjunction with a de facto leader other than himself depends on a number of considerations First there is the nature of the interest for which the action-set is recruited certain requirements say homicide can call for larger sets than others say birth rituals for ego s child Some members of the kin-set may recognize only certain obligations and not others Secondly it depends on how far the interests of ego s kin are also involved and the advantages perceived by them They may give help purely as an obligation to ego with the expectation of obtaining reciprocal assistance in their future needs But there are often other advantages and inducements economic reward co operation with certain others among ego s kinsmen political security or advancement expression of opposition to someone who is ego s adversary and the like Thirdly some kinsmen offer more useful assistance than others in particular contexts some may be influential men others may possess special ritual power or knowledge or special skill and others may have previous experience of some value in the matter in hand Fourthly pressures of time and the claims of simultaneous interests of some potential recruits may preclude their inclusion at a particular time Fifth residential proximity

*often makes it easier to recruit some kinsmen rather than others The rel tive urgency of action may be important and the condition of communi tions Sixthly the actual state of interpersonal relations between ego a d each of his kinsmen individually may affect recruitment he is likely to appeal and with more success to those with whom he is more friendly c to whom he has given generous assistance Some kinsmen may have or f that they have a greater obligation to accede to his request Seventhly t de facto leader of the action-set if different from ego may for any of th previous reasons attract or deter potential recruits*

These considerations are applicable to the Qolla case To give one example th reader will recall that Andres Quispe s aggressiveness was on many occasions directed against members of his social support set and it seems reasonabl tha those individuals are not likely to provide Andres with help when he needs it practical reasons (eg lack of sufficient data on many of these points) we mus make the assumption of a high correlation between the size of social support s and the possibilities of recruitment for action sets

We must make another assumption too The indicators of aggressiveness an litigiousness correspond to a ten year period But in the calculations of partial total social support sets we have used the figures which correspond to the date our census 1969 We assume that the rates of change do not differ for individ high and low in aggressiveness and litigiousness even though there may be dif ferences in absolute size

Ideally members of an individual s social support set should come to his ass *ance when he is in trouble If he gets into a fight they should fi ht also or try* stop the fight They should lend support in hearings before the authorities Wh his time is taken up with serious cases they should volunteer to work his fields In instances of serious conflict among the Qolla self help activities are importa [Bolton 1970]

The first hypothesis that we tested is derived from the van Velzen and van Wetering hypothesis We predicted that subjects with a larger number of living brothers would be more aggressive than subjects with few or no living brothers The results indicate that there does not exist an association between th numbe of living brothers and level of aggressiveness (high aggressors = 1 6 low aggresso 1 5 P = NS) If one uses an age-controlled sample (since number of living brothers is an age related variable) then a statistically significant relationship emerges when one considers those who have a living brother versus those who ha no living brother (see Table II) This finding could be interpreted as pro id g some slight support for the social support or fraternal interest group hypothesis since this division into those with a brother versus those without a brother cor responds to the presence versus absence of fraternal interest groups However other interpretations of this relationship could be advanced

TABLE II Number of Living Brothers and Aggressiveness

| Number of living brothers | Aggressiveness | |
|---|---|---|
| | High | Low |
| None | 2 | 9 |
| One or more | 25 | 17 |

$x^2 = 5\ 95$ $P < 0\ 02$ (age-controlled sample)

1) The reputation for aggressiveness might be gained because of fighting among brothers this possibility too would seem to fit with the fact that the break comes between no brothers and one brother

2) The presence of brothers offers possibilities for training in aggressiveness during childhood

3) Differences in sibling set composition may be associated with differences in childrearing experiences and therefore aggressiveness

If the social support hypothesis is the correct interpretation of the association then we reason this relationship should hold up – indeed be stronger – when we use litigation rates as the dependent variable After all it is in litigation and in the forms of a␣␣ression that lead to litigation that social support is of greatest utility But regardless of whether one uses the complete sample or the age controlled one a relationship between litigation and number of living brothers is nonexistent although it should be pointed out that there is a slight tendency which is not statistically significant for subjects with no living brothers to engage in more total litigation a similar tendency approaches significant levels when one considers litigation as plaintiff separately ($x^2 = 2\ 76$ $P < 0\ 10$ $df = 1$ $n = 53$) The fact that subjects with no living brothers may be more willing to take com plaints to judicial authorities may indicate a willingness on the part of villagers to act aggressively toward individuals without a significant support set without a fraternal interest group Having living brothers may serve as a deterrent against attack and thereby lower involvement in litigation When we examine rates of litigation as defendant we find no relationship whatsoever with the number of living brothers If those with brothers are more aggressive than those without brothers then having brothers may also protect them from litigation as defendants the injured party may be more reluctant to sue an opponent who has a male sib ling What is troubling about these findings is the fact that they apply not to the number of living male siblings but only to the case where there is one or more versus none If this line of thought were correct then the results should emerge

also when the independent variable is continuous rather than dichotomous ʃ this is not the case we conclude *that the social support hypothesis with resp* to living male siblings receives minimal support at best

What can be said about the other interpretations of the association betwee presence of a living brother and aggressiveness? We believe that the third inte pretation offers the greatest promise – ie that differential socialization expe are involved Where one finds large sibling sets one is likely to find less atten and care devoted to each child Physical punishment is more likely to occur tl in smaller families [Bolton and Bolton 1972] These factors should lead to u creased aggressiveness One way to test this interpretation is through an exam tion of birth-order data In Qolla society preferential treatment is accorded b the first born child especially a male and a male last born child There exists statistically significant relationship between birth order and aggressiveness fii and last born males are less aggressive than middle born males (Since age and birth order are unrelated phenomena we have used the complete sample to te this hypothesis ) In Table III we present the pertinent data Birth order and *litigiousness are not associated in this sample*

In addition to this work on the number of brothers a systematic and thorc search for associations between other segments of social support sets and agr siveness and litigiousness was carried out Specifically we attempted to find c relations between the dependent variables and the number of ego s living fem siblings (maximum 6 minimum 0) of sons 15 years old or older (4 0) of daughters 15 years old or older (5 0) of total living offspring 15 years old or older (8 0) of compadres chosen for ego s children s haircutting (11 0) bapti (11 0) and marriage (10 0) of compadres who chose ego to serve as godfathe for their children s haircutting ritual (9 0) baptism (6 0) and marriage (9 0) the total number of times ego was chosen to be a godfather (15 0) and the to number of times ego chose others to become a compadre (28 2) Relationship were also sought with whether or not ego s and his wife s parents and godpare were still living (each type tested individually) Finally correlations were sou with figures calculating the size of ritual kin sets for ego and his wife (the ran in size from a maximum of 40 to a minimum of 7) the size of ego s kin set – i offspring parents and siblings (maximum 22 minimum 3) – and the size of th complete social support set – ie a combination of the kin set and ritual kin set (maximum 61 minimum 18)

It is clear that as a result of demographic processes (largely though not exclu ly) there exists considerable differentiation with respect to the amount of sup person in Incawatana might possibly mobilize in time of trouble Yet the resu of our search were overwhelmingly negative That is there were only five signifi relationships ($P < 0.05$) of a total of 104 tests and even these findings which in any event simply reflected what one might expect by chance were not in a dire tion that would favor the social support hypothesis

TABLE III Birth Order and Aggressiveness

| Birth order | Aggressiveness | |
|---|---|---|
| | High | Low |
| First or last child | 9 | 17 |
| Middle child | 24 | 14 |

$x^2 = 5.02$ $P < 0.05$

Consequently it seems reasonable to conclude that the social support hypothesis does not succeed in explaining differences in aggressiveness and litigiousness in the Qolla context Although failure to find support for the social support hypothesis can be viewed as evidence in favor of the supposition that Qolla aggressiveness and litigiousness are not highly instrumental it is possible of course that the failure simply means that potential support from kinsmen and ritual kinsmen does not enter into the instrumental calculus employed by Qolla men before engaging in agonistic behavior Other social and economic factors may be important nonetheless and before deciding that instrumental aggression is insignificant it might be best to examine relationships between social status dimensions and aggressiveness and litigiousness

## SOCIAL STATUS AGGRESSION AND LITIGATION

The second set of hypotheses that we tested involves social status To what extent is status differentiation or status inequality related to differential aggressiveness and participation in litigation? From a variety of theoretical perspectives (eg frustration–aggression theory relative deprivation theory and the hypoglycemia hypothesis) one would tend to predict an inverse correlation between aggressiveness and social status On the other hand if Qolla aggressiveness and litigiousness are instrumental and have adaptive consequences for the individual permitting him to gain access to valued resources then we should find positive relationships between aggressiveness and litigiousness and social status To complicate the problem of course forces could be operating from both directions in which case we should expect no relationship whatsoever between some indicators of status (eg wealth) and aggressiveness or conceivably a bi modal distribution with individuals at both ends of the status continuum rated as highly aggressive the aggression of the poor being largely expressive and the aggression of the rich being instrumental

Taken together the following elements define in great measure the social standing of adult males within Incawatana 1) wealth 2) education 3) age 4) participation in communal rituals and 5) participation in the political life of the community

in more total litigation than did less highly educated subjects ($r_s = 0.61$, $P < 0.0$[illegible]) and the more highly educated men were more likely to be involved in litigation as plaintiffs than were the less highly educated men ($r_s = 0.60$, $P < 0.05$). Rates of litigation as defendant, though, were unrelated to educational attainment.

These findings suggest that while education has no influence on aggressiveness, it may predispose individuals to seek redress for perceived wrongs through judicial proceedings. It is likely that education equips the Qolla villager with a better understanding of the legal system, enhances his confidence in his ability to utilize the system (if only because of the increase in knowledge of Spanish gained in school), and improves his strategic competence. Conceivably he initiates more litigation because his higher status per se raises the chances of a favorable outcome, i.e., he can obtain his objectives more readily through litigation than through cruder means more likely to be perceived as "aggressive." The more educated individual engages in neither more nor less behavior of a type which is likely to result in his being sued, or if he does engage in more such behavior than does a less educated person, he is more successful at avoiding the legal consequences.

## The Age Factor

Although there are no special perquisites accruing to the aged and no council of elders at the village level in Incawatana, increasing years do bring with them an increase in status, general respect and some ceremonial deference. This is true as long as aging is not accompanied by a decrease in other components of status; for instance, in wealth, a poor old man is not likely to enjoy high status.

Our analysis suggests that aggressiveness declines with age to some extent ($r_s = 0.30$, $P < 0.02$). However, litigiousness is not significantly related to age. Old and young were involved equally in litigation as plaintiffs, as defendants, and as a whole.

## The Ritual Factor

The religious cargo system in Incawatana is complex and cannot be described in detail in the present context. Sponsors are required for various fiestas in the yearly ritual cycle; indeed, most fiestas include multiple events each requiring one or more sponsors. The major periods when sponsors are called for include Carnival, Holy Week, and the fiesta of the patron saint of the community. The sponsors may pay for the Mass, for dance groups, for expenses associated with the raising of altars, for decorating images of the saints, and for fireworks displays. Most sponsors, of course, must also entertain the retinue of relatives and friends who aid them in carrying out their duties. Cargos vary in expensiveness and prestige, and normally a cargo career involves starting with the less costly and less prestigious cargos and proceeding to those higher in rank. Most individuals participate in the cargo system since participation is expected, particularly of those who have accumulated some wealth. Pressure is exerted on community members who fail to volunteer for a cargo if it is felt that they are capable of handling [illegible]

bility Participation in the cargo system is necessary though not sufficient to attain and maintain high status

To operationalize the ritual participation factor we have tabulated the number of cargos held by an individual without attempting to rank them Efforts to discover stastistically significant associations between ritual participation on the one hand and aggressiveness and litigiousness were unproductive At most there appears to exist a slight tendency for individuals high in ritual participation to engage in more total litigation and more litigation as plaintiff than do individuals low in ritual participation

### The Political Factor

The political structure of Incawatana contains a large number of authority positions teniente alcalde segunda jilacata school board graveyard keeper and others Some positions have more than one occupant for example there are at any one time several tenientes in Incawatana

Occupancy of most of these positions is of limited duration and tends to rotate among interested and willing adult males While some men never accept public positions others serve in one position or another repeatedly There exists the risk of over involvement in the political life of the community a man who appears too eager to serve as teniente and too often is suspected of wanting the post in order to enrich himself from the fees paid for settling disputes But on the whole having served as an authority adds to an individual s status While the villagers of Incawatana tend not to display a high degree of respect for office holders (indeed at times they would seem to enjoy defying the authorities) men are proud to claim having held such and such position

Political participation was operationalized by counting the number of political posts an individual had held during his lifetime this varied from none to five Although there were trends indicating that political participation was associated positively with litigiousness and aggressiveness the results were not statistically significant But attention should be directed to one important finding All nine individuals in our sample who had served in the post of teniente the position with the most prestige and power were considered high in aggressiveness (binomial test $P < 0\ 002$) The interpretation of this finding is problematic since several possibilities come to mind It is conceivable that only the more aggressive men in the community are willing or able to function in the role of teniente which is one that requires the holder to become involved in the conflicts of fellow villagers in order to try to resolve them Or perhaps having served as a teniente these men are perceived as more aggressive because of the role they had to play while an authority Finally it is possible that having to be aggressive to perform as teniente may lead to a continuation of such behavior even after the person no longer holds the position As might be expected because of their above average familiarity with the judicial system tenientes tend to engage in more personal litigation than do those who never served as teniente but these findings are not statistically significant

### The Social Status Index

In order to arrive at an overall assessment of the relationship between social status and aggressiveness and litigiousness it was necessary to construct a social status index incorporating information from the five main components of status identified earlier — ie wealth age education ritual participation and political participation Such an index was devised by assigning to each subject a score of from one to four on each of the five separate status components according to the attributes the subject possessed on a given indicator The maximum score obtained on this index (highest status) was 18 and the minimum score was 7 (lowest status) Using this approach no association is found between social status and aggressiveness but there is a positive correlation between social status and litigiousness as plaintiff ($r_s = 0\ 69$ $P < 0\ 05$) and total litigation scores ($r_s = 0\ 62$ $P < 0\ 05$)

## SUMMARY AND CONCLUSION

In this paper we have explored the relationships between agonistic behavior and social phenomena in an effort to determine whether such behavior among the Qolla is instrumental in character Two different measures of agonistic orientation were used one of these which we have labeled aggressiveness is based on key informants ratings of the extent to which men in the sample of adult males from *Incawatana engaged in fighting violence and other actions intended to be harmful* to an opponent the second agonistic measure is litigiousness which involves the frequency of involvement by these same men in litigation over a ten year period

The pattern of results strongly suggests that aggressiveness and litigiousness while certainly related to each other are conceptually distinct The highly aggressive individuals tend also to be highly litigious to be sure but significantly they tend to be particularly involved in litigation as defendants (rather than as plaintiffs) even though there is a positive association between rate of *involvement* by individuals in litigation as plaintiffs and as defendants

The social support hypothesis did not fare well in relation to agonistic behavior With one possibly meaningful exception neither litigiousness nor aggressiveness seems to be influenced by the availability of potential supporters that is, people bound to ego by bonds of kinship or ritual kinship While prejudicial to the social support approach to agonistic behavior these findings are not surprising They provide confirmation of the assessment that Qolla society *is atomistic* [Rubel and Kupferer 1968] and that solidarity even within the nuclear family tends to be fragile [Bolton and Bolton 1975] An individual cannot count on others for support in a crisis Indeed those who should provide support who are morally required to help because of kinship and compadrazgo ties may be the very ones with whom an individual is engaged in struggle

The exception mentioned earlier as an instance of possible evidence favoring the social support hypothesis however attenuated involved the existence of a male siblin since having a brother was associated with higher levels of aggressive ness in our subjects That a similar finding did not emerge with respect to litigation raises important issues of interpretation After all, fraternal interest groups could use judicial processes too to further their instrumental goals Lawsuits brought before the villa e authorities are occasions for acrimonious and emotional debates between opponents and persons other than the primary parties are allowed to join in the proceedings the outcome of which might be influenced by the num bers present on each side An additional problem for the social support interpreta tion of the relationship between fraternal presence and aggressiveness is the fact that the size of the fraternal group is irrelevant — ie shows no correlation with aggressiveness Thus it seems plausible that if the association between the existence of a brother and aggressiveness is not merely fortuitous causes unrelated to the social support dimension might be involved for example differential socialization practices associated with birth order and sibling set size and composition Althou h it was beyond the scope of the present paper to test this alternative thoroughly some available information suggests that socialization effects mediated by birth order might be operative

Failure to replicate a cross cultural finding at the intracultural level may or may not be significant [Shweder 1976] but given the above results we would like to raise the possibility that the research which prompted the present investiga tion (ie that of van Velzen and van Wetering [1960] and that of Otterbein and Otterbein [1965]) might be profitably re-examined These scholars used residence patterns to index fraternal interest groups (present they suggest in patrilocal societies) The Otterbeins also used polygyny to index fraternal interest groups But are these two indicators not also associated with differential socialization practices eg father absence in the case of polygyny? Bacon et al [1963] have demonstrated a correlation between mother–child sleeping arrangements and personal crimes Further confirmation was provided by B Whiting [1965] Then too polygyny and patrilocality are associated with diets low in protein [J Whiting 1964] and we would like to suggest therefore that as a consequence of hypo-glycemia induced by a protein deficient diet and associated stressors these societies might have higher levels of irritable aggressiveness [see Bolton and Vadheim 1973] The aggressiveness produced by physiological factors and by socialization practices could be responsible for the failure to develop political institutions which could if present control feuding This alternative to the fraternal interest group hypothesis merits testing

Turning to other social factors it could be argued that social status might affect aggressiveness in various ways [Pertti and Gretel Pelto personal com

munication] For example poorer individuals might be likely to engage in behavior seen as aggressive in order to acquire resources needed for their survival the less educated men may be less cautious about their behavior less capable of genteel management of interpersonal relations and therefore more likely to be judged aggressive by their peers However as report above aggressiveness was not associated with overall social status or with three of the separate indicators of status wealth education and ritual participation Understandably in biological terms there was a negative assc iation between age and aggressiveness And to some extent there appears t be a positive association between politico juridical participation and aggressi men who serve as authorities being more likely to be viewed as aggressive Wi additional information it is difficult to sort out the direction of causality in t relationships involved in this specific finding

Our findings in regard to social status variables and litigiousness are almos reverse of those with aggressiveness The more highly educated subjects do er in more total litigation and more litigation as plaintiff than do the less educat ones Education may indeed incline an individual to respond with more restr to provocations and to utilize judicial processes to attain goals The positive association between wealth and litigiousness both total and as plaintiff may from an ability to pay and perhaps too from the fact that those with proper are more likely to experience damages some of which might be produced acc ally and others inflicted intentionally from envy (envidia) Litigiousness appe to be unaffected by age and ritual participation and only minimally so by po participation (if at all)

On the basis of this analysis I would conclude that social support factors c not explain differential aggressiveness and litigiousness among the Qolla and further that their irrelevance gives additional strength to previous conclusions cerning the biological and expressive nature of this aspect of Qolla behavior A the same time this analysis allows us to see that other social and economic fac while not implicated in aggression per se are related to responses to aggressive behavior specifically to the resort to judicial processes People high in social status in wealth and education are most likely to initiate legal proceedings Tl while aggressiveness is minimally instrumental litigiousness may indeed be hi governed by instrumental considerations in Qolla society

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AGGRESSIVE BEHAVIOR
Volume 5 pages 257–267

# Centrally Elicited Aggressive Behavior
## A Model System for the Study of Episodic Neurobehavioral Pathologies?

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Studies in which the predatory like attack of a cat upon a rat has been elicited by electrical brain stimulation have been briefly reviewed with an emphasis on the question of where within the central nervous system such brain stimulation is producing its behaviorally meaningful effects. Two opposing but by no means mutually exclusive views are considered The first is that brain stimulation elicits this behavior pattern primarily because it affects a specific motivated behavior system that is organized discretely in the midbrain and pons. The second is that forebrain neural activity is modulated in behaviorally significant ways by brainstem stimulation which elicits predatory like aggressive behavior in the cat.

The possibility that further research on the altered state of central nervous system activity induced by brain stimulation which elicits aggressive behavior in the cat may lead to a further understanding of the altered states of central nervous system activity that underlie the aggressive dyscontrol syndrome and other episodic state disorders is discussed

Key words aggression predation episodic neurobehavioral disorders hypothalamus brainstem electrical brain stimulation cat

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## INTRODUCTION

Much of clinical psychiatry – particularly in the more severe disorders characterized by intense discrete behavioral patterns that are to varying d reversible and separable clinically and therapeutically from long term per traits which may characterize the steady state behavior of patients Ep of aggressive dyscontrol as well as severe depression manic overactivity o chotic ideation are clearly due to altered patterns of central nervous syste activity They are patterns in that they are reversible and no known struct *abnormalities can usually be demonstrated Although the neural substrate* vulnerability underlying any of these conditions is unknown the result is t the central nervous system captive to abnormal behavioral programming processing of sensory information is biased flexibility in interpretation and sponse *is lost* basic central functions such as sleep and appetite *are altered* the content of subjective experience is determined by the form of the patte of central nervous system dysfunction

In the attempt to understand the changes in central nervous system activ that underlie such behavioral state changes one of the most significant deve ments of the last decade has been an appreciation of the extent to which th functional state of the entire forebrain is dependent on the level of neural a in various lower brainstem cell groups The suggestion 10 to 15 years ago t alterations in neural activity of small groups of brainstem neurons (eg locus coeruleus midbrain raphe) could monosynaptically affect the neural activit the entire cerebral mantle would not have been taken seriously Now it is ac that at least several lower brainstem neuronal groups possess this capacity T potential significance for altering all aspects of cortical functionin includin those mental functions unique and most significant to man is profound of these groups especially the monoaminergic ones have been subjected to i sive investigation and theories of affective disorders and schizophrenia have proposed However because of the very general breadth of effects that follo manipulation of monoamine systems (practically all behaviors in which orga can engage are affected) the answer to one of the critical questions – in wha way do such cell groups alter forebrain neural activity to produce the *specifi* aberrant patterns of behavior we describe as aggressive manic depressive or psychotic? – *is unlikely to come solely from this avenue* of research The dis of other brainstem neuronal groups that influence the neural activity of the f brain but in ways that impose *specific* coherent behavior patterns would be important advance Their study could contribute to our general understandin how ascending modulatory systems produce the patterns of central nervous tem dysfunction that underlie the different episodic behavior disorders In t regard recent research which has found that electrical stimulation of discret

areas in the midbrain [Bandler 1975 1977 Bandler et al 1972 Proshansky and Bandler 1975] and pons [Berntson 1973] elicits a well integrated predatory like attack by a cat upon a rat may be important

## CENTRALLY ELICITED ATTACK BEHAVIOR

Parallels between the altered states of central nervous system activity that under lie certain episodic behavior disorders and the altered states of central nervous sys tem activity induced by brain stimulation that elicits aggressive behavior in the cat have previously been noted [Bowers 1974] These relate to similarities in terms of stimulus input biasing and to limitations in the flexibility of the response Because they have been reviewed elsewhere [Bowers 1974 Flynn 1976 Flynn and Bandler 1975 Flynn et al 1971] together with the important evidence that the effects of unilateral brain stimulation that elicits attack are largely lateralized within the central nervous system they will not be discussed further here Instead we will focus on the question of where within the central nervous system such brain stimulation may be producing its behaviorally meaningful effects

The hypothalamus has long been central to all theorizing on the neural basis of this behavior I think there are at least two reasons for this First the hypothalamus is known to be important for autonomic-endocrine-emotional adjustments and is a central structure through which the limbic system affects behavior in these spheres Second the lateral hypothalamus was the first region in which stimulation was found to elicit predatory like behavior [Wasman and Flynn 1962] Yet as far back as 1968 Ellison and Flynn showed that after surgical isolation of the hypothalamus cats could still be motivated to show natural predatory behavior and predatory like attack behavior could still be elicited by stimulation of the midbrain reticular formation Since natural and centrally elicited predatory behavior were present in a brain with a neurally disconnected hypothalamus this study quite convincingly demonstrated that the hypothalamus is not concerned with the organization of this behavior pattern but rather with the modulation of other areas in the brain where the behavior must be organized

There is no shortage of such areas In the 15 years since the behavior was first discovered forms of predatory like attack behavior have been reported during stimulation of the posterior midline thalamus [Bandler and Flynn 1974 Mac Donnell and Flynn 1968] the preoptic region [Bandler 1979 Inselman and Flynn 1972] the midbrain ventral tegmental area [Bandler et al 1972 Proshansky and Bandler 1975] the midbrain reticular formation [Sheard and Flynn 1967] the rostral midbrain dorsal periaqueductal gray substance [Bandler and Flynn 1974] the caudal midbrain supratrochlear periaqueductal gray substance [Bandler 1975 1977] the dorsolateral pontine tegmentum [Berntson 1973] and the fastigial nucleus of the cerebellum [Reis et al 1973] (see Figs 1–3)

Fig 1 Map of preoptic hypothalamic and thalamic points from wh ch pr datory attack has be n elicited by electrical stimulati n in th c t Complied from B ndler [1979] Flynn [1967] In lman and Flynn [1972] MacDonnell and Flynn [1968] Siegel and Cl bo [1971] Si gel t al [1972] and W m n nd Flynn [1962] S tion e drawn o ding to th atl of J p r and Ajmon M san [1954] Ant o f ont l pl ne fo e h se tion l in th upp ight o n Abb tion A a umi n nu l s AC nt lo mmi u C cau l t nu l u Cm ent l m di l nu l u of th l mu DM do m li l n l u of tl l nu

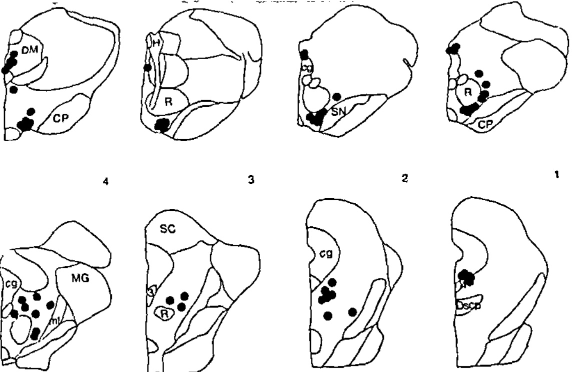



Fig 2 Map of thalamic and midbrain points from which predatory attack has been elicited by electrical stimulation in the cat Compiled from Bandler [1975 1977] Bandler et al [1972] Bandler and Flynn [1974] Flynn [1967] MacDonnell and Flynn [1968] Sheard and Flynn [1967] and Wasman and Flynn [1967] Sections are drawn according to the atlas of Jasper and Ajmone Marsan [1954] Anterior frontal plane for each section is in the upper right corner Abbreviations CP cerebral peduncle Dscp decussation of superior cerebellar peduncle DM dorsomedial nucleus of thalamus H habenula MG medial geniculate nucleus of thalamus R red nucleus SC superior colliculus SN substantia nigra cg central gray substance of midbrain ml medial lemniscus 3 oculomotor nucleus 4 trochlear nucleus

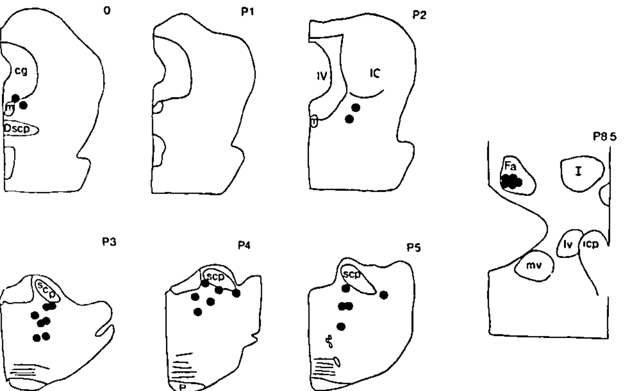



Fig 3 M p of pontin nd b ll r points f om whi h p d tory tt ck ha b n llcit d by l ct i l timul tion i th cat Compil d f om B ndl [1977] B nt on [1973] nd R is t l [1973] Not th t R i t l [1973] did not in l d l l tol gy in l i p p h f n d o l wo k S i n P8 5 d wn f om Miu nd R i [1970] Se lon l wn o di g to ll n Sn de nd N n [1961] P n i p n o l se lon i in l u p hi n Abb l l D p l

## DESCENDING ORGANIZATIONAL MODEL

Of all these sites the discovery of several discrete regions in the midbrain and pons deserve particular attention

It has been known for some time that the presence of large lesions of the anterior hypothalamic preoptic region [Bergquist 1970] or surgical isolation of the hypothalamus [Ellison and Flynn 1968] do not eliminate the attack elicited by lateral hypothalamic and midbrain reticular formation stimulation respectively whereas small lesions in the midbrain ventral tegmental area [Proshansky and Bandler 1975] or large lesions made in the midbrain reticular formation [Berntson 1972] eliminate hypothalamically elicited attack behavior In addition while electrical stimulation of preoptic hypothalamic midbrain and pontine regions elicit predatory like attack behaviors that are seemingly identical in form and target selectivity much higher intensities of stimulation are required to elicit the behavior with preoptic or hypothalamic stimulation than with mid brain or pontine stimulation [Bandler 1977 1979 Proshansky and Bandler 1975] (see Fig 4)

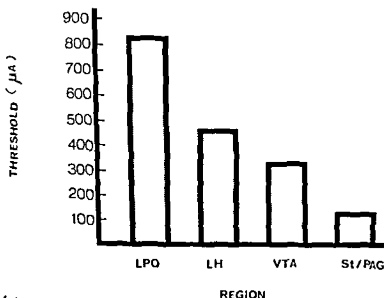



Fig 4 Average minimum intensity of stimulation required to elicit attack upon a rat in less than 15 seconds for five of six trials on each of three days Compiled from Bandler [1975 1977 1979] Each average minimum intensity is derived from individual thresholds for no fewer than 18 electrodes in each region Intensity of stimulation data was not reported for pontine tegmental attack sites [Berntson 1973] but Berntson (personal communication) has indicated they are comparable to those in the St/PAG region Abbreviations LPO lateral preoptic region LH lateral hypothalamus VTA ventral tegmental area of midbrain St PAG supratrochlear periaqueductal gray region

Taken together these studies have led many to the conclusion that neuronal groups in the midbrain and pons organize this behavior and that it is these regions which in turn are modulated by stimulation of the rostral brainstem (ie preoptic region hypothalamus and thalamus) [Bandler and Flynn 1974 Bergquist 1970 Berntson 1972 1973 Chi and Flynn 1971 Chi et al 1976 Flynn 1976] While this view may yet prove to be substantially correct the data are by no means unequivoval

## ASCENDING MODULATORY MODEL

The problems with what we can perhaps call the descending organizational model of centrally elicited aggressive behavior in the cat are as follows First several recent studies [Bandler 1975 1977 1979 Bandler and Fatouris 1978 Proshansky and Bandler 1975] have drawn attention to the fact that there are almost certainly large regional differences in the configuration of the common neuropil likely affected by stimulation in the preoptic region lateral hypothalamus, and midbrain ventral tegmental area – the medial forebrain bundle – and that the differential effectiveness of lesions in the anterior hypothalamic preoptic region versus those in the midbrain region may simply be due to the greater compactness of the medial forebrain bundle in the caudal region Thus even large anterior hypothalamic preoptic region lesions are ineffective perhaps because they are less likely to destroy neuropil in common with other lateral hypothalamic attack sites than are small ventral tegmental area lesions The different results of lesions in these regions then may tell us nothing about the directionality of stimulation effects Second so similar are the attack behaviors elicited by stimulation of different regions (preoptic region lateral hypothalamus midbrain ventral tegmental area midbrain supratrochlear central gray area pontine tegmentum) [Bandler 1977 1979 Berntson 1973] that it is probable that the stimulation is affecting a common neural substrate Yet the known anatomical interconnections of these areas do not suggest such a common descending neural substrate The only study [Chi et al 1976] that has specifically examined this question failed to find any significant anatomical projections from the three interconnected [Chi and Flynn 1971] attack-eliciting rostral brainstem regions (preoptic region hypothalamus midbrain ventral tegmental area) to the two known attack-eliciting caudal brainstem regions (supratrochlear central gray area pontine tegmentum). This is all the more significant as the attack threshold stimulation intensity data suggest that there should certainly be substantial convergence of the descending projections from the relevant rostral brainstem regions onto the relevant caudal brainstem regions The only known common neural substrate linking these five regions is the *ascending* medial forebrain bundle Finally in a recent study Berntson et al [1976] drew attention to the extent to which the predatory behavior elicited by brain stimulation resembles natural predatory behavior if cats

are tested with live rats in a naturalistic environment For example in such an environment stimulated cats will use their paws to drive a live rat from behind an obstacle that makes it impossible for the cat to bite the rat Such complex intentional behavior would seem to require that the brain stimulation modulate forebrain as well as brainstem neural mechanisms Just that has in fact been proposed In a review Siegel and Edinger [1978] concluded that the stimulation that elicits attack must ultimately produce altered pattern of neural activity in parietal temporal and frontal neocortices If this proves to be sub stantially correct stimulation of the rostral brainstem (preoptic region lateral hypothalamus midbrain ventral tegmental area) may well alter cortical neural activity via effects on components of the ascending medial forebrain bundle Ascending pathways other than those within the medial forebrain bundle would likely be involved in the effects of stimulation in other regions as we have already noted the finding that midbrain reticular formation stimulation (not to be con fused with midbrain ventral tegmental area stimulation) elicits attack after surgical isolation of the hypothalamus [Ellison and Flynn 1968]

## TWO MODELS QUESTIONS AND SPECULATION

The discovery of discrete regions in the lower brainstem at which low inten sities of stimulation elicit a complex motivated behavior then serves to focus attention on a most important question Does brain stimulation elicit this behavior pattern primarily because it affects a *specific* motivated behavior system that is organized discretely in the midbrain and pons? Or is forebrain neural activity modulated in behaviorally significant ways by the brainstem stimulation that elicits predatory aggressive behavior in the cat? If the latter what determines the form of the elicited behavior the stimulated modulatory system(s) or the function of the affected forebrain regions? We do not know the answers to these questions but they are important with respect to the general significance of the centrally elicited predatory attack model

The concept that the central nervous system possesses some kind of *latent capacity* for patterns of functioning (or dysfunctioning) that underlie the aggressive dyscontrol syndrome(s) and other episodic state disorders is central to all theorizing on the biological bases of mental illness Electrical stimulation of the brain then offers one method of revealing certain of these capacities including perhaps capacities thought to be uniquely dependent on forebrain neural tissue In this regard the fact that stimulation of certain lower brainstem regions in the cat elicits a predatory like aggressive behavior may be misleading It is worthwhile I believe to remember that the cat is a carnivore and the product of a unique evolutionary history Because the cat is a mammal nowhere would we expect the effect of that history to be reflected in central nervous system development more than in the development of the forebrain It would not be any more surprising then to

find that alterations in the neural activity of brainstem cell groups that project to widespread regions of the forebrain in the cat would affect predatory behavior than to find that manipulation or abnormal functioning of the same brainstem neuronal groups in man could alter mental functions or consciousness In the two species comparable patterns of altered forebrain neural function could well produce alterations in different behaviors

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
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# Predatory Attack Behavior in the Cat Elicited by Preoptic Region Stimulation A Comparison With Behavior Elicited by Hypothalamic and Midbrain Stimulation

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The predatory attack of a cat against a rat elicited by preoptic region lateral hypothalmic and ventral midbrain stimulation has been compared Regardless of the region stimulated the attack behaviors were found to be nearly identical with respect to response topography preference for the rat as an attack object the distance at which the cats would approach and attack a rat and the success in finding and attacking the rat when the cats were blind folded However the minimum current required to elicit the predatory attack by preoptic region stimulation was two to three times greater than that required to elicit the same behavior by lateral hypothalamic and ventral midbrain stimulation It was considered that the medial forebrain bundle is likely to provide the common neuropil affected by stimulation in each region and that its differing regional density may explain the results

Key words aggression, predation preoptic region hypothalamus midbrain electrical brain stimulation cat

## INTRODUCTION

Wasman and Flynn [1962] first reported that electrical stimulation of the lateral hypothalamus of the cat elicited a quiet predatory like biting attack on a rat Since then it has been found that electrical stimulation of many other regions of the central

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nervous system elicits similar forms of behavior posterior midline thalamus [Mac nell and Flynn 1968 Bandler and Flynn 1974] preoptic region [Inselman and I 1972] midbrain ventral tegmental area [Bandler et al 1972 Proshansky and Ban 1975] rostral midbrain dorsal central gray substance [Bandler and Flynn 1974] midbrain reticular formation [Sheard and Flynn 1967] caudal midbrain supratr chlear central gray substance [Bandler 1975 1977] central pontine tegmentum [ son 1973] and fastigial nucleus of the cerebellum [Reis et al 1973] This mul of sites from which predatory like behavior can be elicited indicates that the elicit behavior has a quite widespread and complex neural organization within the bra An understanding of the neural relations of the regions from which such attack be can be elicited would seem to be essential if we hope to understand where within central nervous system the electrical stimulation is having behaviorally meaningful fects *A first step is to compare the behaviors elicited by stimulation of different r* gions of the brain

It is generally accepted that quiet biting attack elicited by stimulation of the la hypothalamus and ventral tegmental area of the midbrain is dependent on the i te of a common neuropil – the medial forebrain bundle [Proshansky and Bandler 19 Flynn 1976 Chi et al 1976 Bandler 1977] Rostrally the medial forebrain bu occupies a large cross-sectional area of the preoptic area a region from which a q predatory like attack behavior has been elicited [Hutchinson and Rendrew 1966 I man and Flynn 1972] For this reason we thought that a comparison of the atta avior elicited by stimulation of the preoptic area lateral hypothalamus and mi n ventral tegmental area could likely provide important information abo t the elationship of these attack-eliciting regions as well as about the functional o g on of the medial forebrain bundle with respect to this form of aggressive behav

## THODS

nitial observations were made on 27 cats (15 females 12 males) at least one r they arrived in the laboratory to determine if any of them spontaneously a rats This was tested on each of 3 days by placing the cat for 2 hours in a test c 3 X 3 ft) containing food and water and then introducing into the ca a 00- gm albino rat for an additional 2 hours Only the 24 cats (13 females 11 males ch did not show any aggression toward the rats were selected for the study All were maintained on an ad libitum food and water schedule from the time they ved in the laboratory

Each of these 24 cats was fitted under aseptic conditions with 10–12 electrode guides mounted over holes drilled in the skull at appropriate stereotaxic coordinates for the implantation of electrodes into the preoptic region lateral hypothalamus a

ntral tegmental area of the midbrain The coordinates according to the atlas of Jas-
r and Ajmone Marsan [1954] were as follows midbrain Ant 5 0–7 0 Lat 2.3 hypo
alamus Ant 10 0–12 0 Lat 2.5 preoptic region Ant 14 0–16 0 Lat 2 0 and Ant
.0 Lat 4 0 The electrode guides consisted of 10-mm pieces of 18 gauge wax filled
podermic tubing A wire which was attached to several stainless steel screws embed
d in the skull served as the reference electrode The monopolar stimulation electrodes
re made from 24-gauge stainless steel rods etched to sharp points in an electrolytic
h of hydrochloric acid and insulated with 3 coats of baked priming paint The tips
re bared for 0 60 mm and the maximum outside diameter of the shafts was 400 μm.
stimulation consisted of biphasic square wave pulses of 1 msec half cycle duration
eat d at a frequency of 60 Hz with the current flow through the cat s brain mea
ed on an oscilloscope

After each cat had recovered from surgery (4–7 days) it was placed in the test cage
a deeply anesthetized rat and a bowl of food A sterile calibrated monopolar elec
le was then advanced in approximately 0 25–0.50 mm steps through one of the
les into the preoptic region hypothalamus or midbrain of the cat Stimulation was
ied out at each step and the animal s behavior was noted Stimulation currents in
range of 100–1,500 μA were employed during this procedure the choice of cur
being dependent on both the vigor and kind of behavior elicited For example
e stimulation seemed aversive and the cat attempted to escape from the cage the
ent was decreased or if no behavior was elicited the current was raised until be
oral changes were observed or until 1 500 μA was reached In this way the behav
potential of each site stimulated as the electrode was lowered was determined
respect to the test environment When stimulation elicited a direct approach to
at and a persistent biting attack on the rat the electrode was cemented into place
procedure was repeated until each guide had been implanted with an electrode
electrode was advanced to the base of the brain and attack had not been elicited
s removed and the guide sealed with bone wax to prevent infection

uring the first three days which immediately followed the electrode implantations
eak to peak threshold intensity required to elicit a biting attack on the rat with
ency of less than 15 seconds was determined for the attack sites This was done
ach site by initially stimulating at an intensity that elicited attack within 15
nds and then descending in 50 μA intervals to an intensity at which attack was
licited within 15 seconds on two consecutive trials The intensity was then raised
A and additional trials run If attack was elicited within 15 seconds for five of six
this intensity was taken as the attack threshold If not the intensity was raised
n 50 μA steps until the above criterion had been reached The reliability of
hreshold was verified by testing the electrode at the attack threshold intensity to
riterion of attack within 15 seconds for five of 6 trials on each of 3 additional

days If the attack threshold proved unreliable a new threshold was determined Indi-
vidual stimulation trials lasted no more than 20 seconds and at least five minutes el
between trials

Testing of points continued for up to six weeks following the determination o
the attack threshold intensities. During this time eight cats with attack sites in the pre-
optic region lateral hypothalamus and/or the midbrain ventral tegmental area under-
additional behavioral testing in order to compare the attack behavior elicited during
stimulation of each area The cats selected were those that had attack sites with the
most stable thresholds

Attack object preferences were tested by stimulating the cats with no object in
the test cage and with the following objects in the test cage rat only (R) rat-size
*wood or styrofoam block (B) food and water (FW) all objects (R/B/FW)* rat paired
with wood or styrofoam block (R/B) rat paired with food and water (R/FW) As the
were seven conditions these tests were run in blocks of seven trials each with the or-
der of conditions within each block of trials randomized Individual trials lasted no
more than 20 seconds with at least five minutes between trials Twelve sites in each
area (preoptic region hypothalamus midbrain) were tested under these conditions
at their attack threshold intensities An attack site in one region was stimulated for
each block of trials but the order of sites tested for a cat was randomized between
blocks Only one block of trials was run for a single site each day with six blocks of
trials at each site overall Thus, there were 72 trials for each condition with attack
stimulation in the preoptic region in the hypothalamus and in the midbrain Follow-
ing completion of this testing the cats had an additional block of six trials of attack
stimulation at each site a) while blindfolded with the rat in the test cage to deter-
if during such stimulation the cats could find and attack the rats without visual guida
b) in an eight foot long cage to determine if they would approach and attack a rat fro
that distance

After the completion of this testing the steepness of the attack threshold was e
ated for six sites in each region This was done by determining at each site the maxi
intensity at which 15 seconds of stimulation never elicited attack upon the rat (0 of
eight trials) and the lowest intensity at which stimulation always elicited attack upon
the rat (eight of eight trials) Testing began at the attack threshold and continued if
less than 500 $\mu$A in 10 $\mu$A intervals above and below the attack threshold until the cr-
terion of an attack in less than 15 seconds on eight of eight trials was met If the at-
tack threshold was between 500–1 000 $\mu$A the testing was done in 20 $\mu$A intervals
if over 1 000 $\mu$A in 50 $\mu$A intervals To determine the no attack threshold the se-
*descended until an intensity was found at which* stimulation failed to elicit attack with-
in 15 seconds on eight trials Individual trials never exceeded 20 seconds with at least
five minutes between trials No more than four trials were run at a given intensity f
one site on any day with no more than 20 trials at the same site on any day

At the completion of testing each cat was anesthetized and perfused with physio-
logical saline followed by 10% formalin The brains were removed embedded in

celloidin sectioned and stained with hemotoxylin and eosin The location of all electrode tips was determined by microscopic examination of the brain sections

## RESULTS

### 3ehavioral

Stimulation of 19 preoptic region sites 36 lateral hypothalamic sites and 30 ventral :egmental area sites elicited quiet biting attack behaviors which were seemingly identi :al in form (ie crouched posture stalking like movements biting directed to the head ınd neck of the rat and lack of observable autonomic effects other than pupillary dila ation and mild piloerection) In addition to the topographical similarities the predatory ıke behaviors elicited by stimulation of the three regions were nearly the same with espect to the preference for the rat as an attack object the maximum tested distance t which the cat would approach and attack the rat and the cat s behavior when blind olded As is seen in Table I regardless of the region stimulated if the rat was in the

**ABLE I A Comparison of the Biting Attack Elicited by Stimulation in the Preoptic Region iteral Hypothalamus and Ventral Tegmental Area of the Midbrain**

| egion imulated | Condition | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | R | R/B | R/FW | R/B/FW | R Bld | R 8 ft | FW | B |
| eoptic area | 66 | 62 | 64 | 64 | 48 | 52* | 26a | 23a |
| iteral hypothalamus | 69 | 70 | 65 | 68 | 51* | 61 | 7 | 5 |
| entral tegmental area of midbrain | 70 | 69 | 67 | 69 | 41* | 53* | 2 | 0 |

he number of trials out of a total of 72 in which the rat was bitten within 15 seconds of the iset of stimulation is indicated for the following conditions R only rat in test cage R/B t and rat-size wood or styrofoam block in test cage R/FW rat and food and water in test ige R/B/FW rat rat-size wood or styrofoam block and food and water in test cage Bld only rat in test cage but cat blindfolded R 8 ft only rat but in special 8 ft long test ge The number of trials (72 maximum) in which only food and water was in the test cage id the food or the food and water containers were bitten within 15 seconds of the onset stimulation is indicated for the condition FW The number of trials (72 maximum) in hich only a rat-size wood or styrofoam block was in the test cage and it was bitten within 5 seconds of the onset of stimulation is indicated for the condition B

ignificantly different ($P < 0.001$ chi-sq test) from stimulation of other regions in the same ondition

($P < 0.001$)

($P < 0.01$) Significantly different (chi-sq test) from stimulation of same region in condition R.

($P < 0.05$)

here were no significant differences (chi-sq test) in the frequency of attack between regions ı either the R Bld or R-8 ft conditions

cage the cats showed no consistent tendency to attack inanimate objects such as a r size wood or styrofoam block food and water containers the cage walls or floors h ever with preoptic region stimulation (seven electrodes) and to a lesser extent with l teral hypothalamic stimulation (two electrodes) the cats would bite intermittently a the wood block or food and food and water containers if the rat was not in the test cage In this regard it needs to be mentioned that a general feature of the implanta of the preoptic region with movable electrodes was the frequent tendency to elicit fragments of behavior Many times as electrodes were lowered through the preoptic region biting of the rat was elicited but only if the rat was within a few inches of the cat When the rat was moved several feet away the stimulated cat failed to approach the rat but would instead bite at the wire mesh floor or food dish if it was nearby Su sites were not considered to be reliable predatory attack sites and with further lowering of these electrodes even these fragments of coordinated attack dropped out For oth implanted electrodes approach and licking of the rat and in the absence of the rat licking of the cage floor and grooming was elicited While such behavior was occasionally elicited during implantation of the lateral hypothalamus and mid brain ventral tegmental area it was certainly not a general feature It is also seen in Table I that either placing the rat eight feet from the cat or blindfold ing the cat significantly reduced (chi square tests) the number of trials on which the rat was attacked within 15 seconds However this reduction in frequency of attack was observed for stimulation in each region and there were no significant differences (chi square tests) in the extent of the reduction between regions

One feature which uniquely characterized the stimulation in each region was the at tack threshold These are shown in Figure 1 It can be seen that the mean threshold f the elicitation of predatory attack with ventral tegmental area stimulation was 310 μA In contrast an average of 465 μA of current was required with lateral hypothalam stimulation and nearly three times the ventral tegmental area current 840 μA was re quired to elicit attack with preoptic region stimulation It is also seen in Figure 1 that the regional changes in attack threshold were abrupt rather than gradual In Figure 1 this is most apparent for stimulation in the lateral hypothalamus and the preoptic re gion Thus it can be seen that attack thresholds within the lateral hypothalamus (Ant 10 0–12 0) and preoptic region (Ant 14 0–16 0) were stable whereas an 80% in[illegible] in the intensity of stimulation required to elicit attack occurred within the two mm of tissue between the lateral hypothalamus (Ant 12 0) and the preoptic region (Ant 14 Although it is not shown in this figure previous research indicates that the change [illegible] attack threshold while smaller (40%) between the midbrain and hypothalamus can be even more abrupt occurring within the 1 mm of hypothalamic tissue between Ant 9 0 and Ant 10 0 [Bandler 1977] Table II provides information about the range of attack threshold values in each region Another feature which was different in each re gion was the ease of finding sites from which predatory attack could be elicited Using the identical movable electrode implantation procedure 65% (36 of 55) of the electrodes implanted in the lateral hypothalamus yielded attack In contrast 4[illegible]

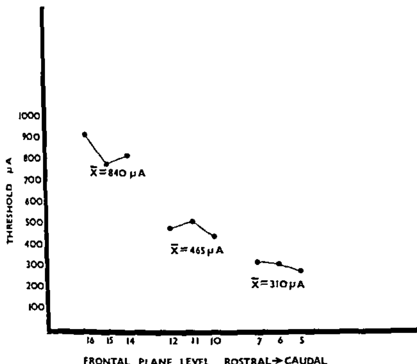



Fig 1 The average threshold intensity for eliciting predatory attack by electrical stimulation is indicated for groups of electrodes implanted at frontal planes from Ant 5 0 to Ant 16 0 The data are from 24 cats and 85 electrodes Each point represents the average attack threshold intensity for at least five electrodes at each frontal plane level Differences between average attack threshold intensities for the three regions midbrain ventral tegmental area (Ant 5 0–Ant 7 0) lateral hypothalamus (Ant 10 0–Ant 12 0) and preoptic region (Ant 14 0–Ant 16 0) were significant ($P < 01$ t tests) Attack threshold intensities in microamperes (peak to peak) are represented on the ordinate Frontal plane levels from Ant 5 0 to Ant 16 0 according to the atlas of Jasper and Ajmone Marsan [1954] are represented on the abscissa

(30 of 66) ventral tegmental area electrodes and only 25% (19 of 78) preoptic area electrodes elicited attack This preoptic area figure may be low in part because of the tendency for such stimulation to elicit seizures This was the case for an additional six electrodes which initially elicted attack but had to be discarded from the study as repeated stimulation produced limbic type seizures (salivation twitching of facial muscles etc ) Including these electrodes would raise the preoptic region yield to 30% (25 of 84 electrodes) still far below the 65% yield in the anatomically adjacent lateral hypothalamus The lateral hypothalamic and ventral tegmental area figures are in accord with those previously reported [Proshansky and Bandler 1975 and Bandler 1977] Finally there were also regional differences in the steepness of the

**TABLE II** Steepness of Attack Threshold in Midbrain Ventral Tegmental Area, Hypothalamus and Preoptic Region

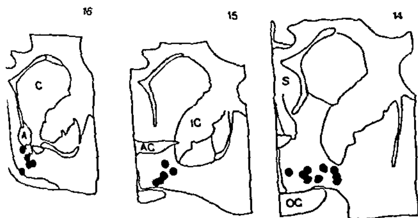
| Site | Cat | No attack | 100% attack | % Change |
|---|---|---|---|---|
| | | Ventral Tegmental Area | | |
| 6 0R | 12036 | 240μA | 320μA | 33% |
| 6 0L | 12036 | 180μA | 250μA | 39% |
| 6 0L | 15027 | 200μA | 240μA | 20% |
| 7 0R | 17027 | 280μA | 340μA | 21% |
| 8 0R | 11306 | 300μA | 400μA | 33% |
| 8 0L | 12036 | 680μA | 760μA | 12% |
| Mean = | | 315μA | 385μA | 26% |
| | | Hypothalamus | | |
| 10 0R | 10086 | 290μA | 440μA | 52% |
| 10 0R | 12036 | 360μA | 520μA | 44% |
| 11 0R | 10086 | 310μA | 400μA | 29% |
| 12 0L | 11256 | 210μA | 360μA | 71% |
| 12 0R | 01197 | 280μA | 380μA | 36% |
| 12 0L | 15027 | 520μA | 700μA | 35% |
| Mean = | | 330μA | 465μA | 44% |
| | | Preoptic Region | | |
| 14 0R (a) | 01197 | 800μA | 1200μA | 50% |
| 14 0R (b) | 01197 | 560μA | 800μA | 45% |
| 14 0R | 20097A | 600μA | 840μA | 40% |
| 14 0L | 20097B | 580μA | 800μA | 38% |
| 15 0R | 17027 | 620μA | 780μA | 26% |
| 16 0L | 20097B | 640μA | 960μA | 50% |
| Mean = | | 630μA | 895μA | 42% |

attack thresholds It can be seen in Table II that for attack sites in the ventral tegmental area and lateral hypothalamus there was no significant difference in the maximum stimulation intensity (315 vs 330 μA) at which attack was never elicited. However whereas a 26% increase in this intensity elicited a 100% reliable attack for ventral tegmental area stimulation a 44% increase in stimulation intensity was required before this level of reliability was achieved with lateral hypothalamic stimulation (this difference was significant P < 0 05 t test) For preoptic region sites the maximum intensity at which attack was never elicited was significantly higher than that in the ventral tegmental area or lateral hypothalamus (630 μA vs 315 μA and 330 μA) However the mean increase in intensity required to elicit 100% reliable attack was nearly identical to that required *with lateral hypothalamic stimulation* (42% vs 44%)

stological

El-trode tip locations of attack sites in the lateral hypothalamus and ventral teg ental area have be n described in great detail in previous reports [Bandler et al 1972 oshansky and Bandl r 1975 Flynn 1972] and will not be shown here Electrode location for the preoptic region attack sites are shown in Figure 2 It is seen that ack is elicited from a very widespread area especially within the caudal preoptic region support of this conclusion is the observation that for three cats attack was elicited comparable intensities from pairs of electrodes which were implanted at approximately same coronal plane (Ant 14 0) but at both 2 0 mm and 4 0 mm lateral to the midline pectively Within the lateral hypothalamus and ventral tegmental area electrodes im anted only within a much narrower (approximately 0 5–1 00 mm) medial lateral zone it predatory behavior

These histological findings are seemingly in sharp contrast to the earlier report of elman and Flynn [1972] that attack behavior is elicited only from the medial pre tic area and the more medial portions of the lateral preoptic area One difference in se two studies is that from their histology it appears Inselman and Flynn implanted y 29 electrodes in the preoptic region in contrast to the 84 (including the seizure ding electrodes) el ctrodes of this study More importantly they implanted no




2 Map of preoptic points from which predatory attack was elicited by electrical stimula n in the cat Elect ode tip locations indicated by solid circles. Sections are drawn accord to the atlas of Jasper and Ajmone Marsan [1954] *Anterior frontal plane for each sec n is in the upper right corner* breviations A accumbens nucleus AC anterior commissure IC internal capsule optic chiasm S septum

electrodes in the lateral portions of the caudal lateral preoptic region (Ant 13.5–14.5
This caudal lateral preoptic region is precisely the area in which five of our 19 attack
electrodes were located (see Fig 2) Inselman and Flynn s conclusion then is based
on their inadvertent failure to explore this region Within the more rostral reaches of
the preoptic region (Ant 15 0–16 0) we found that eight of 10 attack electrodes
were either in the medial preoptic region or the medial portions of the lateral preop-
tic region and thus is in substantial agreement with Inselman and Flynn [1972] A
second factor that may have contributed to the differences in the two studies is that
Inselman and Flynn [1972] used a maximum stimulation intensity of 800 μA Of th
19 preoptic attack-eliciting electrodes in this study, only 10 electrodes elicited re
liable attack at intensities of 800 μA or less although it should be noted that three o
these were in the lateral portions of the lateral preoptic region The different results
of the two studies then are seemingly reconcilable Within the rostral reaches of
the preoptic region attack is elicited from the medial preoptic area and the medial
portions of the lateral preoptic area whereas in those portions of the preoptic region
contiguous with the anterior hypothalamus predatory like attack is elicited from a
widespread region extending from the medial to the far lateral preoptic region It m
be noted that the first mention of biting attack elicited by preoptic region stimulatic
includes a site in this far lateral caudal preoptic region [Hutchinson and Renfrew
1966]

## DISCUSSION

It is well established that the ascending and descending components of the medial
brain bundle are most compactly arranged within the ventral tegmental area of the
brain and that they come to occupy increasingly large cross sectional areas in succes-
sive lateral hypothalamic and preoptic region levels That the medial forebrain b ndl
provides the common neuropil which would be affected by stimulation in each regi
likely explains the similarity in the form and selectivity of the elicited predatory
behaviors The differing regional anatomy may well explain many of th regional dif
ferences

With respect to the lateral hypothalamus and ventral tegmental area the att k
threshold intensity differences the differences in the steepness of the attack threshd
and the differing probabilities of eliciting attack behavior with implanted electrodes
all in accord with the medial forebrain bundle anatomy Thus because of the greater
compactness of the medial forebrain bundle within the ventral tegmental area we
expect that it should be harder (than it would be in the lateral hypothalamus) to im-
plant electrodes in the proper spot but when so placed lower intensities of stimulat
should affect a greater proportion of the medial forebrain bundle yielding s eeper a
lower attack thresholds Other factors however may be involved as well For exam
within the midbrain moderate intensities of stimulation elicit more dramatic com
ing motor responses than in the lateral hypothalamus Such responses could certai

under the discovery of other ventral midbrain sites that might only elicit attack at high stimulation intensities Still the greater steepness of the attack threshold in the ventral tegmental area cannot be explained by competing responses Further in a recent study [Bandler and Fatouris 1978] we found that prior (priming) stimulation of attack sites in the ventral tegmental area was more effective in altering the subsequent excitability (reducing attack latencies) of stimulation at lateral hypothalamic sites than was prior stimulation at adjacent lateral hypothalamic sites This suggested that there was a greater correspondence between the neuropil affected by stimulation of a ventral tegmental area attack site and a lateral hypothalamic attack site than there was between that affected by two lateral hypothalamic sites Such results are in accord with assigning the greater compactness of the medial forebrain bundle in the midbrain ventral tegmental area a major role in explaining differences in the effects of stimulation of these two regions

Exactly the reverse explanation the diffuseness of the medial forebrain bundle in the preoptic region may offer a partial explanation of the preoptic region results That is perhaps because of the diffuseness of the medial forebrain bundle within the preoptic region only with very high intensity stimulation is enough of the attack relevant neuropil affected to elicit a biting attack on the rat In this regard it should be recalled that in the absence of the rat stimulation of some preoptic attack sites elicited biting at inanimate objects and in addition that a general feature of implantation of the preoptic region with movable electrodes was the tendency to elicit fragments of behavior It has previously been suggested that the neural pathways mediating the approach to the rat and the biting of the rat are anatomically separable [Proshansky and Bandler 1975] In this context both the fragmentation of behavior observed during electrode implantation in the preoptic region and the tendency for preoptic region attack stimulation to elicit generalized biting in the absence of the rat may indicate an anatomical separation of functionally relevant components (ie biting in one case approach in the other) within the medial forebrain bundle in the preoptic region In summary we are speculating that because the medial forebrain bundle is relatively compact in the lateral hypothalamus and midbrain ventral tegmental area stimulation in these regions usually elicits complete attack sequences (ie approach and biting) whereas in the preoptic region because the medial forebrain bundle is more diffuse stimulation is more likely to not elicit attack or to elicit only components of the attack sequence (ie approach or biting) There may as well be other factors such as a unique regional synaptic physiology that contribute to the increased probability of fragmented behavior in the preoptic region

It has previously been reported that large anterior hypothalamic lesions do not affect the predatory behavior elicited by stimulation of the caudal lateral hypothalamus [Bergquist 1970] On the other hand small ventral tegmental area lesions [Proshansky et al 1974 Proshansky and Bandler 1975] or large midbrain reticular formation lesions [Berntson 1972] eliminate the attack elicited by lateral hypothalamic stimulation We had thought [Proshansky and Bandler 1975] as have others

[Bergquist 1970 Berntson 1972 Chi et al 1976 Flynn 1976] that the differential effectiveness of these lesions indicated that the hypothalamic and midbrain stimulation elicited attack behavior because of the effects of the stimulation on descending neural pathways While this interpretation may yet prove to be substantially correct the data of this study are also consistent with another interpretation namely that the posterior hypothalamic and midbrain lesions may be effective not because of the directionality of the stimulation effects but simply because of the greater compactness of the medial forebrain bundle in the posterior lateral hypothalamus ventral midbrain tegmental region Thus even large anterior hypothalamic preoptic region lesions may be ineffective because they are less likely to destroy neuropil in common with other lateral hypothalamic attack sites than are small midbrain ventral tegmental area lesions

When lesions are made in two different regions such as the anterior hypothalamic preoptic region and the ventral tegmental area and we suspect that there are large differences in the configuration of the neuropil affected by the lesions the interpretation of results is difficult For this reason any conclusions about the directionality of stimulation effects would seem to be premature

In a recent study Berntson et al [1976] drew attention to the extent to which the predatory behavior elicited by stimulation resembled natural predatory behavior if the cats were tested with live rats in a naturalistic environment For example in such an environment stimulated cats used their paws to drive a live rat from behind an obstacle which made it impossible for the cat to bite the rat Such complex behavior would likely depend upon forebrain rather than brainstem mechanisms In a review article Siegel and Edinger [1978] have gone further and suggested that in the intact cat the neocortex is likely involved in the organization and character of the centrally-elicited attack behavior Modifying Flynn s [1972] terminology they proposed the term cortical patterning mechanism and suggested that the brain stimulation that elicits attack must ultimately produce altered patterns of neural activity in parietal temporal and frontal neocortices

If this proves to be substantially correct the results of this study suggest that electrical stimulation of the preoptic region lateral hypothalamus and midbrain ventral tegmental area may well alter forebrain neural activity via effects on components of the ascending medial forebrain bundle However ascending pathways other than those within the medial forebrain bundle would likely be involved in mediating the effects of attack stimulation in other regions as it should be recalled that Ellison and Flynn [1968] have reported that midbrain reticular formation stimulation (not to be confused with midbrain ventral tegmental area stimulation) elicits attack after surgical isolation of the hypothalamus

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
Volume 5 pages 283–290

# Factors in the Waning of Muricide in the Rat II Digging Behavior

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If each mouse killed by a rat is removed from the rat s home cage and replaced immediately by another the decline in the rate of killing within the one-hour sessions is accompanied by an increase in digging in the woodchip bedding material Deprivation of the opportunity to dig by removal of the bedding material results in a statistically significant increase in kill rate Since no other behaviors monitored showed a similar increase with this manipulation it appears that digging may be a mechanism important in the waning of muricide Furthermore digging may be in some sense a functional equivalent of killing.

Key words muricide habituation displacement digging

In an earlier study [Potegal Marotta and Gimino 1975] we found that the characteristics of the intrasession waning of muricide were not those of habituation at least as defined by Groves and Thompson [1970] In searching for alternative mechanisms underlying this intrasession decrement we noted a marked increase in a form of forward-directed digging which accompanied the decreases in muricidal behavior Although digging may occur in other situations eg immediately after the bedding material (woodchips) has been changed it seemed possible that the increase in digging during the session might play a role in the waning of muricide

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Digging particularly in agonistic situations has been described as a displace ment behavior in various species of rodents including the prairie dog [Smith Smith Oppenheimer deVilla and Ulmer, 1973] vole [Clarke 1956] multimam mate mouse [Veenstra 1958] and rat [Barnett 1958 Grant 1963] Although the notion of displacement behaviors has been quite controversial in part becau of its association with the now discredited energy conservation' theories of motivation [Hinde 1970] recent evidence [Wilz 1975] has shown that the occurrence of such behaviors may indeed have a functional role in modifying an organism s subsequent aggressive behavior

In the current context it is conceivable that the occurrence of foward diggin may influence the probability of subsequent killing Delius hypothesis [1967] that displacement behavior may act as a de arousal mechanism implies that the occurrence of displacement digging could reduce muricide rates Similarly Heiligenberg [1965] noted that some species of cichlids increase digs at the substrate under certain conditions in which their attack readiness had also increased He argued that the failure of attack rates to rise after a bout of digging indicates that the digging counteracted the spontaneous increase in attack rate that routinely occurred during these particular conditions These observations could be encompassed in a satiation model of muricide in which digging was a motivational equivalent of killing In these circumstances it could be predicted that deprivation of the opportunity to dig would tend to increase kill rates

Alternatively digging could conceivably facilitate killing post kill digging may act as a warm up for the next kill In a study of agonistic encounters in jungle fowl Feekes [1972] found that pecking at the ground opportunistically directed toward particles of sand on the floor was positively correlated with occurrence of an agonistic side display posture When the sand was removed and ground pecking consequently eliminated the incidence of aggressive pecking and kicking at conspecifics was also reduced in these encounters This is the only study of aggres sive behavior known to us in which the opportunity to perform displacement behaviors has been manipulated

We decided to put these alternative hypotheses about killing and digging to the test by comparing the kill rates of muricidal rats with or without the oppor tunity to dig

## METHOD

*Subjects* Our subjects were male Long Evans hooded rats 6–12 months old which had killed the first mouse put into their home cage within 5 minutes *Five* of these animals (the prior experience group) had killed a mean of 165 mice (10 mice/session approximately) in our previous experiments on *intersession interval* effects [Potegal et al 1975 Exp 2] We compared the behavior of *these subjects* with that of 6 additional naive rats selected by the same criterion from the same

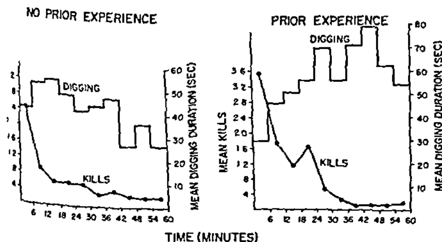
sto k (no prior experience group) However we rejected any rat that killed more
i 25 mice in any of the first 3 sessions Subjects were singly housed and main
u in large plastic home cages as described in our previous report The cages
routinely filled with Sani-chip bedding material (Animal Feeds Bronx New
to a depth of 2 5 cm The bedding material was changed twice weekly on
s in which no behavioral testing was done

*Procedure* All subjects were tested for 20 one hour sessions in their home
a es with or without the woodchip bedding material in a repeated ABBA order
n the woodchip-absent condition the woodchips were removed 12 hours before
sting The intersession interval was at least 48 hours A session began when a
mouse grasped with forceps was presented into a corner of the cage not
by the rat When the mouse was killed it was immediately removed and
ed by a new one hence a live mouse was almost continuously present
the session A continuous record of killing digging grooming feeding
during the session was made by the experimenter with a 20-pen event
In addition any nipping rough grooming or sudden strikes toward the
as recorded as attack

## ESULTS

### oral Relationship of Muricide and Digging

Figure 1 illustrates the average time courses of killing and foward digging
thin all woodchip present sessions Note that digging increased at the beginning




g. 1 Mean intrasession distribution of number of kills and duration of digging in successive minute periods.

of the session as the first burst of killing waned Digging then started to decli toward the end of the session These effects were more pronounced in the experienced group This group also showed a transient increase in muricide in 18–24th minute period followed by a surge of digging in the next 6 minute These peaks also appeared in separate analyses of the first 10 and last 10 sess indicating that they were a stable feature of muricide in this group The occu of such successive peaks was also detected, with a somewhat different analys our earlier study [Potegal et al 1975]

### Results of Woodchip Removal

The removal of the woodchips substantially reduced but did not entirely eliminate foward digging since eight of the subjects occasionally dug at food pellets feces or even the bare cage bottoms This appears to be an in vacuo' digging response [Lorenz 1957] In conjunction with these in vacuo digging attempts we have seen two of the rats pick up food pellets or feces in their mouths and drop them on or near the mouse Since digging is often directed towards the mouse and occasionally results in the mouse being covered by a mound of woodchips [Potegal et al 1975 cf Pinel and Treit 1978] this beh may be an interesting case of response equivalence Similar observations have made in prairie dogs [Smith et al 1973]

Overall nine of the 11 subjects killed more mice when the woodchips were absent (Wilcoxon signed rank matched pairs test T=9 P < 0 05) The mean bers of mice killed per session in the first 10 and last 10 sessions in both cond tions are shown in Table I Two findings suggest that the relationship between digging and killing may have become stronger with experience Firstly Wilcox tests of differences between all sessions with or without woodchips for individ subjects showed significant kill rate differences between conditons for each of of the 5 subjects with prior muricide experience (P < 0 001 for each) None c the six rats without prior experience had statistically significant individual int

TABLE I Mean Number of Kills/Session

| | N | Sessions 1–10 Woodchips | Sessions 1–10 No woodchips | Sessions 11 0 Woodchips | Sessions 11 0 No woo |
|---|---|---|---|---|---|
| No prior experience | 6 | 7 2 | 7 3 | 6 5 | [illegible] |
| Prior experience | 5 | 9 6 | 12 9 | 6 4 | [illegible] |

condition differences Secondly over all subjects differences between conditions in sessions 1–10 were not significant while inter-condition differences in sessions 11–20 were significant (T=4 P<0 01) There were no differences between con ditions in any of the other behaviors monitored including attack There were no differences in duration of digging in woodchips between first 10 and last 10 sessions

To test the hypothesis that the increase of killing in the absence of woodchips reflected the absolute or relative prepotency of killing in our standard wood chips present condition we calculated the percentage increase in killing between conditions for each subject Spearman rank order correlations across all subjects were made between 1) the percentage increases and kill rates and 2) the percentage increases and kill rate/grooming duration ratios No significant correlations were found between the absolute or the relative (to grooming) amount of killing in the woodchip condition and the percentage increase between conditions

## DISCUSSION

### Temporal Relationship Between Killing and Digging

Over the whole session killing and forward digging tended to be reciprocally related Within certain portions of the session peaks in killing were followed by peaks in digging Other studies have also turned up a diversity of temporal relationship between aggressive behavior and displacement activity Gallagher Herz and Peeke [1972] found that picks at the bottom of the aquarium were positively correlated with bites directed at a neighboring conspecific in convict cichlids However Peeke and Peeke [1972] reported that bottom pick frequency was inversely related to frequency of predatory attack by goldfish on brine shrimp In correlational studies on several species of cichlids Heiligenberg [1965] and Rasa [1971] concluded that the occurrence of "digging or chafing reduces subsequent aggression Interestingly Rasa [1971 p 48] reports that On every occasion a peak in aggressive motivation) is elicited this is followed within the next five minutes one in chafing As in our study Rasa s results showed that displacement activity and overt attack were sometimes directly and sometimes reciprocally related Our study further suggests that these relationships can be strengthened with experience We know of no other demonstrations of this kind

### Effects of Deprivation of Digging

Depriving rats of the opportunity to dig significantly increased mouse killing at least in rats selected for low initial rates of killing These results contrast with those of Feekes [1972] who found decreases in conspecific attack following deprivation of ground pecking in junglefowl Difference in species experimental situations and motivational systems clearly render comparisons problematic

Several possible explanations exist for our effects One of the most obvious interpretations is the response competition hypothesis with the time formerly

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AGGRESSIVE BEHAVIOR
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# Visual Target Control of Schedule-Induced Aggression in White King Pigeons (Columba livia)

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Visual target control of schedule-induced attack was studied in domesticated pigeons by exposing them to successive and simultaneous target preference procedures involving a fixed time food schedule and projected target images. Pigeons preferred attacking an image of a conspecific head over a headless bird regardless of the height of the latter Images of an intact bird and of a head alone were equally effective in controlling attack and more effective than the headless bird Neither the eye nor four other head related features exclusively controlled attack. The combined results suggest that the head of an intact conspecific target selectively controls schedule induced attack and that the effectiveness of the head in directing attack is inversely related to its physical integrity as a unit without regard to specific features. These results are consistent with reports that the head and head related features of an intruder control reproductive aggression in birds.

Key words aggression schedule-induced pigeon conspecific target preference visual features

## [illegible]UCTION

Schedule induced shock-elicited and other types of irritable aggression [illegible]oyer 1976] are directed toward a variety of targets including conspecifics [illegible]es and inanimate objects Experiments that have used a conspecific for studying irritable aggression typically find that gross changes in its be

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havioral and physical properties can significantly influence aggressive behavior (eg Azrin Hutchinson and Hake 1966 Powell Francis Braman and Schneiderman 1969 Hynan 1976 Cohen and Looney 1973 Knutsen 1973] Looney and Cohen [1974] reported that a global change in just the visual aspects of a conspecific target affect schedule induced aggression in pigeons They found that an image of a conspecific silhouette is more effective in controlling aggression than is a comparable inverted silhouette outline of a conspecific or colored paper The present experiments assess the specificity of visual target control of schedule induced aggression in domesticated pigeons In particular the experiments determine if the head of a colored conspecific target image which is the locus of contact [Looney and Cohen 1974] selectively controls schedule induced attack. Such selective visual control would be consistent with the results of studies on reproductive aggression in birds [eg Smith and Hoskings 1955 Stout and Brass 1969]

## GENERAL METHOD

### Subjects and Apparatus

Seventeen male domesticated White King pigeons (from Palmetto Pigeon Plant Sumter South Carolina) were maintained at 75% (±20 gm) of their free feeding weights Supplemental feedings of mixed grain following test sessions were given when necessary Birds were visually isolated in individual home cages with free acce s to water and health grit under a 16/8 hour light/dark cycle

Pigeons were tested six days/week in a 34 9-cm X 34 9-cm X 30 8-cm test chamber A 5 0 cm X 5 7-cm opening (9.5 cm above the floor) centered on one chamber wall allowed subjects access to mixed grain when the food hopper (BRS/LVE 114-10) was raised A photocell was mounted below the food tray opposite the hopper light so as to accurately time each eating bout from its onset. Centered on the wall opposite the hopper were two 12 5-cm X 16 5-cm Polaroid plastic screens spaced 8 5 cm apart center to-center Each screen was suspended by two frame mounted micro-switches (Micro Switch No 311SM701T) centered behind an 11 5-cm X 15 3-cm opening in the black rear wall The bottom edge of the screens was 7 6 cm above the chamber floor An attack was defined as displacement of any point on either screen with a force of approximately 0 1N (measured by a Jonard dynamometer) In order to prevent damage to the screen and eliminate reflections each screen was covered with a piece of seamless Scotch Brand Magic Mending Tape

### Targets

Located directly behind each screen was a random access projector [Cohen Yoburn and Looney 1976] which displayed on that screen colored conspecific or degraded conspecific images (Figs 1 and 2) on an illuminated background. An










Fig. 1 Black and white photographs of the rear view projected colored con specific targets used in Experiments 1, 2 and 3

background alone (blank target) was used in conjunction with images in Experiments 2 and 3 The image of the intact conspecific was 15.3 cm high the head located at approximately the subject s head height The distance from the center of the eye to the tip of the beak was 3 8 cm which is approximately that of a live White King pigeon The size of the head and headless images with same as those features of the intact image In addition all degraded images except the raised headless were positioned on the screen in the same as the intact image As shown in Figure 1 the raised headless image was placed to the upper edge of the screen During sessions in which the projectors used they provided the only light source in the chamber approximately 1.37 candles/m² each During all other sessions the rear chamber wall was replaced a smooth black surface and chamber illumination was provided by two 6 3 1 6-W lights located in the ceiling in front of the food hopper panel.

...ing and recording of experimental events was controlled by relays timers counters located in a room adjacent to the chamber White noise and an exhaust fan served to partially mask extraneous sounds

## Preference Procedure

During testing all animals were exposed to a fixed time 90-second schedule of food presentation which permitted limited access to food every 90 seconds independently of the animal s behavior Each of 30 three second food presentations during a session was timed from the moment of interruption of the hopper photocell light A session began with a food delivery and ended with 90 seconds without

A protective contingency was programmed for all experiments such that a scheduled food delivery was delayed until target responding had not occurred for 5 seconds This arrangement ensured that attacks on the target were not adventitiously reinforced by food [Azrin and Hutchinson 1967]

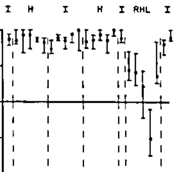
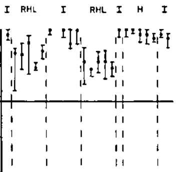
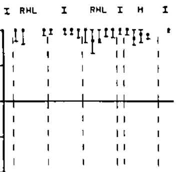
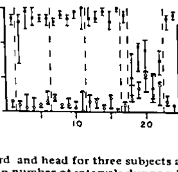
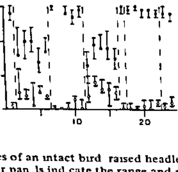
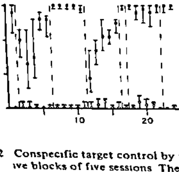








Fig. 2 Conspecific target control by images of an intact bird raised headless bird and head for three subjects across ucc ive blocks of five sessions The lower pan ls ind cate the range and median number of intervals during which a fi t atta k occurr d on the blank t get (O) versu the con pecific m ge (■) The upper panels how the n edian sen ti ity ind x (SI) nd ange SI of +1 0 0 0 and −1 0 corre pond to a complete p f nce for the on pe f c

The targ t preference procedure involved concurrent exposure to the fixed time and a pair of rear view projected target stimuli During each target prefer e session only one pair of stimuli was used and only one stimulus appeared screen at a time

While subjects were feeding the relative position of a pair of stimuli semi andomly changed between screens such that the location of the stimuli was ometimes diff rent at the end of each feeding bout Within a session each stimu s appeared on each screen an equal number of times during successive blocks f six food pres ntations One of four sequences was repeated every fourth session the position of the two stimuli at the beginning of a session was reversed ly The total number of attacks on each screen cumulative duration (min) of tacks on each screen (switch closure times) recorded in terms of 0 12 second the location of the first attack following each food delivery were recorded ely for both stimuli regardless of position

– T 1

Althou h there has been considerable interest in intraspecific aggression in geons and doves (eg Fabricius and Jan son 1963 Orcutt 1971 Vowles and wood 1966) there is virtually no information about which visual features the conspecifi target control aggression in Columbidae Using White King ie ons the first experiment examines target control by conspecific images of a headless bird and intact bird

1a

This experiment evaluates the pigeon s target preference when given a choice tween attacking images of a head and a headless bird

## ETHOD

Three pigeons (P8835 P6222 P7041) with a history of schedule induced attack nst a conspecific image (Looney et al 1976) were exposed to the standard get preference procedure described above with images semi-randomly changing tion during each food presentation Initially each bird was given a choice be en attacking images of a head and of a headless bird (see Fig 1) for 6–22 ses ons and then between images of a head and of a headless bird raised to head ight for 10–20 sessions

## TS AND DISCUSSION

All three birds had stable target preferences across all test sessions when given oice between attacking an image of a head versus an image of a headless rd in either the normal or head height position Preferences during the final five

TABLE I Target Preferences During Exposure to a Head Versus a Headless Target Image in Either the Normal or Head Height Position*

| Pigeon | Initial attack | | | Total attacks/session | | | Total attack duration (min) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Head | Headless | SI | Head | Headless | SI | Head | Headless | SI |
| | | | | Head vs headless bird | | | | | |
| 8835 | 29 8 | 0 2 | +0 99 | 429 2 | 7 0 | +0 97 | 0 16 | 0 00 | +1 00 |
| 6222 | 24 8 | 0 0 | +1 00 | 433 2 | 5 0 | +0 97 | 0 36 | 0 01 | +0 92 |
| 7041 | 27 6 | 2 4 | +0 85 | 1031 4 | 68 0 | +0 87 | 2 89 | 0 15 | +0 92 |
| | | | | Head vs raised headless bird | | | | | |
| 8835 | 29 2 | 0 8 | +0 95 | 441 0 | 12 6 | +0 94 | 0 81 | 0 03 | +0 93 |
| 6222 | 29 4 | 0 2 | +0 99 | 534 2 | 1 6 | +0 99 | 1 86 | 0 00 | +1 00 |
| 7041 | 27 8 | 2 2 | +0 86 | 1105 4 | 57 6 | +0 89 | 3 24 | 0 07 | +0 96 |

*Means over the last five sessions are presented for location of the initial attack following food (maximum of 30) total attacks/session and total attack duration per session on the head and headless targets The sensitivity index (SI) computed from these means (last five sessions) is presented for each measure

sessions of each target condition are summarized in Table I A sensitivity index (SI) [Frey and Colliver 1973] was computed for each measure of attack over the last five sessions of each condition The SI is an index of image preference independent of position preference

$$SI = \frac{P_1 - P_2}{2(P_1 + P_2) - (P_1 + P_2)^2}$$

where

$P_1$ P(attack left|head left)

$P_2$ - P(attack left|head right)

As computed in this table sensitivity indices of +1 0 0 0 and −1 0 correspond to complete head preference no preference and a complete headless bird preference respectively The upper portion of Table I shows that with the image of the headless bird in its normal position all three pigeons showed a strong preference in terms of all three measures for attacking the screen on which the head was projected Informal observations indicated that these pigeons like those in previous schedule induced attack experiments [eg Looney and Cohen 1974] charged and pecked directly on the head

It is possible that the pigeons were not exhibiting a preference for the image of the head but rather a preference for a head height image over one below head height However the results in the bottom part of Table I indicated that this was not the case With the headless image raised to a subject s head height all three birds continued to show by all measures an extreme preference for attacking the image of the head

In this experiment as well as in Experiments 1b–3 described below the frequency and temporal pattern of attack within a session were comparable to that reported in previous schedule induced attack studies [Flory 1969 Cohen et al 1976] Attack occurred following most of the 30 food deliveries (Table I) with the probability of attack highest following food

## EXPERIMENT 1b

In the previous experiment pigeons preferred to attack an image of a conspecific head over a simultaneously presented image of a headless bird The next phase of the experiment assesses the relative effectiveness of those targets as well as an intact target image when only one image is presented at a time Specifically Experiment 1b determines if images of the head and intact bird are equally effective in controlling aggression when presented singly and if the extremely low levels of attack on the headless bird in the previous experiment were related to the concurrent availability of the head

## METHOD

Attack was established in four of five experimentally naive pigeons using a procedure developed by Looney et al [1976] Briefly pigeons were exposed to a fixed time 90 second schedule with ten 10-second food presentations for 25 sessions with no target image present On the 26th day of exposure to that schedule the image of the intact bird was projected on the right screen and background illumination alone (blank target) was projected on the left screen After 20–21 sessions with those stimuli present birds that had attack rates of 1 0 response/minute or more were exposed to twenty 20 minute sessions with the same target conditions but no food scheduled and then an additional 10 sessions with the FT schedule reinstated Finally each bird was exposed to five additional sessions with the FT schedule in effect but with the target stimuli alternating position during each food presentation

Following this preliminary training birds were exposed to the target preference procedure in which they had a choice between attacking an image of a conspecific (head intact raised headless) or a blank target P8594 and P7834 were given a choice between attacking a blank target and the conspecific images in the following order with the number in parentheses corresponding to number of sessions intact (5) raised headless (25) intact (5) raised headless (25) intact (5) head (25) intact (10) P7928 and P7306 were exposed to the same target images in a different sequence intact (5) head (25) intact (25) head (25) intact (5) raised headless (25) intact (10) As in Experiment 1a targets semi randomly changed position at each food presentation and a test session consisted of 30 food presentations on the FT 90-s schedule

## RESULTS AND DISCUSSION

For three of the four pigeons that attacked the conspecific image during preliminary training continued exposure to the food schedule was necessary to maintain attack Removal and reinstatement of the schedule prior to preference testing resulted in at least a two fold decrease and then increase respectively in attack rates for each bird except P7928 for which there was no effect Long term perseveration of schedule induced attack in the absence of a food schedule was also reported by Looney et al [1976] and on the basis of their results would be expected to decrease with additional exposure to the no-schedule condition

Figure 2 summarizes the results obtained for P8594 P7384 and P7928 when only one conspecific image (head raised headless or intact bird) and the background illumination (blank target) were presented The data for the fourth bird (P7306) is not included in this figure since for unknown reasons it stopped attacking all targets following the second exposure to the intact image (session 55) The lower panel plots the median number of inter food intervals in which the

initial attack occurred on each of the three conspecific images (closed squares) versus the blank target (open circles) over successive blocks of five sessions This measure of attack is positively correlated with median attack rate (Pearson Product moment correlations of +0 82 +0 73 and +0 44 for P7928 P7384 and P8594 respectively) but is more stable from session to session The data in the lower panel are replotted in th upper one in terms of median sensitivity index [Frey and Colliver 1973]

When either the head or intact bird was presented with the blank target all birds tta ked at least once during most inter food intervals (lower panel) In addition 90% or more of those initial attacks were directed toward the conspecific image rather than the blank target which is reflected in sensitivity indices ranging from +0 74 to +1 00 (upper panel) Corresponding data for the fourth bird (P1306) not included in this figure are consistent with that of the other three in that attacks occurred during 80% or more of the inter food intervals with the ... ird or head available and median sensitivity indices ranged between +0 77 ...+1 00

With the image of the raised headless bird present P8594 showed an extreme ...fer n e for it relative to the blank target (median sensitivity indices of +0 93 ...+1 00 upper panel) The remaining two birds (P7384 P7928) showed less of a ...ference for th headless bird (relative to the blank target) than they did for ...ther the head or intact bird All three pigeons however attacked the headless tar... in f wer inter food intervals than they attacked either the head or intact bird (lower panel) Perhaps the discrepancy between preference for the headless target ...nd probability of attacking it ob rved for P8594 is most likely to occur with ... effective targets Such discrepancies al o reported by Looney and ...hen [1974] may justify distinguishing between the direction and release ...Lorenz and Tinbergen 1938 Franck 1966 Baerends and Kruijt 1973] of sched... ...duced aggression by a conspecific target The directive property may be as...sessed in terms of the location of the initial attack on one of two simultaneously ...vailabl targ ts following food delivery and the releasing property evaluated in terms of th number of inter food intervals with an attack or latency of attack following food presentation

Comparable target control by images of the head and intact bird in this experiment indicates that the effectiveness of a conspecific image in sustaining attack is ... monotonically related to target size (area) The physical size of the least effectiv target the headless image was intermediate to that of the head and intact bird On the other hand the fact that the birds reacted in the same way to images ... the head and intact bird suggests that a pigeon may selectively attend to the head of a conspecific target when attacking The partial effectiveness of the head...less bird in sustaining attack may have resulted from it sharing f atures with the head (eg, white feather surface) or from its prior association with the head

## EXPERIMENT 2

The extreme target preference for the head over a headless bird in Experime Ia and the comparable target control by the head and intact target images in E: periment Ib suggests that the head of a conspecific image or some aspect(s) of i may selectively control schedule induced aggression In that case one would ex pect that when presented simultaneously images of an intact bird and head wo be equally effective in controlling attack. On the other hand, when confronted with images of an intact bird and headless bird pigeons should show a consister preference for the intact bird The next experiment examines these questions

## METHOD

The same preliminary training procedure employed in Experiment 1b was u: to establish attack against an image of the intact bird (Fig. 1) in each of the nin experimentally naive birds

Following preliminary training birds were exposed for five sessions to the ta get preference procedure in which they had a choice between attacking an imag of an intact bird or a blank target Targets randomly changed position during ea food presentation Following the fifth session each subject was exposed to a pr session with three birds arbitrarily assigned to one of three probe testing conditi The probe session was identical to the previous baseline conditions except that the blank target was replaced by a comparison target which was either a h adl : image raised headless image or head (Fig 1)

## RESULTS AND DISCUSSION

Removal and reinstatement of the FT schedule prior to preference testing in: cated that the food schedule increased the level of attack. For all birds removal of the schedule resulted in at least a two-fold decrease in attack rate relative to the schedule condition

Target preferences (total attacks/session) are summarized in Table II for both the final baseline session (intact image and blank screen) and the probe session (intact image and degraded comparison image) P9093 P7329 and P7797 (uppe portion) showed an extreme preference for the intact image over the blank targe during the final baseline session (SI = +0 89 to +0 99) but failed to show a stron consistent preference for either the head or intact image during the probe sessior (SI = –0 18 to +0 06) Comparable results (not included in Table II) were obtai from a preliminary study in which the birds previously used in Experiment I we exposed to several sessions with access to images of a head and headless con- specific followed by a probe session with images of the intact bird and head avai able Although all three pigeons initially showed an extreme preference (SI = +0

TABLE II Target Preferences During the Final Baseline Session With the Intact Bird and Blank Target Available and the Subsequent Probe Session With the Intact Bird Versus One of Three Degraded Comparison Targets (Head, Headless or Raised Headless Bird) Present *

| Pigeon | Intact bird | Blank | SI | Intact bird | Head | SI |
|---|---|---|---|---|---|---|
| 9093 | 507 | 3 | +0 99 | 189 | 257 | −0 18 |
| 1379 | 535 | 32 | +0 89 | 398 | 480 | −0 07 |
| 7751 | 717 | 8 | +0 96 | 262 | 256 | +0 06 |
| | Intact bird | Blank | SI | Intact bird | Raised headless | SI |
| 8153 | 108 | 3 | +0 92 | 150 | 6 | +0 85 |
| 8090 | 1155 | 5 | +0 99 | 678 | 132 | +0 69 |
| 8346 | 571 | 5 | +0 98 | 441 | 26 | +0 89 |
| | Intact bird | Blank | SI | Intact bird | Headless | SI |
| 8181 | 54 | 9 | +0 74 | 88 | 27 | +0 55 |
| 8 08 | 148 | 3 | +0 96 | 90 | 2 | +0 95 |
| 8172 | 451 | 25 | +0 90 | 320 | 53 | +0 72 |

*The total number of attack /session on the blank and conspecific targets and the corresponding sensitivity index (SI) are included

to +1.00) for the head relative to the headless bird there was not a consistent preference for either the head or intact bird (SI = −0 44 to +0 26) during the subsequent probe session for any subject

The results for the six remaining pigeons (lower portion of Table II) suggest that the lack of differential target control by the intact bird relative to the head is due to selective target control by the head of the intact target All six birds exhibited a preference for the intact image relative to the blank target during the final baseline session (SI = +0 74 to +0 99) and continued to have a preference (albeit slightly attenuated) for the intact image over a raised or lowered headless target during the probe session (SI = +0 55 to +0 95) This preference for a conspecific target with (rather than without) a head is consistent with the preference for the head over the headless image observed in Experiment 1a In conclusion the preference for the intact image relative to the headless one and the lack of a preference for the intact bird when paired with the head support the suggestion that the head or some property of it selectively controls schedule induced attack. Whether the low levels of attack on the headless images in this experiment reflect some minimal control by the torso or a tendency to attack a novel object or one similar to or associated with an effective target (Thompson and Sturm 1965) remains to be determined

## EXPERIMENT 3

The previous experiments indicate that the head of an intact conspecific ima controls schedule induced aggression in White King pigeons Although most aggressive pecks are directed toward the eye of the conspecific target Looney and Cohen [1974] found suggestive evidence that the eye itself exerted little if any control over attack In the next experiment the target preference proc dure w used to evaluate the role of the eye and each of four other head related feature (color beak head shape and white head surface) in controlling schedule ind aggression

## METHOD

Six pigeons from Experiment 2 (P8153 P8090 P8346 P8181 P8101 P81 were exposed to the target preference procedure with semi randomly changing targets Each bird was given a choice between the image of the standard intact (Fig 1) and the blank screen for 3–5 sessions followed by a probe session inv ing a choice between the same intact bird and a degraded comparison imag w a particular head feature deleted (Fig 3) If the deleted aspect controlled attac this would be reflected in a preference for the intact bird If the feature were little importance in the control of attack the animals should show no preferer This sequence of baseline and probe sessions was used repeatedly to evaluate t get features in the following order color (black and white image with color around eye and on beak deleted) eye beak head shape (square shape with sa area) white head surface (outline) and eye (re exposure)

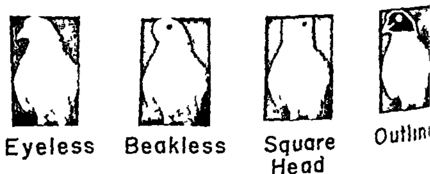



Fig. 3 Black and white photographs of the rear view projected colored conspecific targets used in conjunction with the intact image (Fig 1) in Experime 3

## RESULTS AND DISCUSSION

Figure 4 plots for each bird the sensitivity index (based on total number of attacks) for each of the six probe sessions as well as the mean and range in sensitivity index for the baseline sessions that preceded those probes As in Experiment 2, all pigeons except P8181 exhibited an extreme preference for the intact conspecific over the blank screen (Mdn mean SI = +0 97) Although the variability in baseline preferences for P8181 makes it difficult to evaluate the results of the probe sessions for that bird the data for the remaining five birds indicated that no one aspect of the head selectively controlled aggression and that the relative contribution of each aspect varied somewhat across birds In spite of individual differences between birds certain properties of the head were generally more effective in controlling attack than others The eye and the beak exerted the least control over attack, as evidenced by little preference for the intact target relative to ones without those features Median SI across birds was +0 03 (range −0 16 to +0 76) and +0 08 (range −0 10 to +0 34) for the two eye probes respectively and +0.07 (range −0 11 to +0 18) for the beak probes The white feathered surface of the head and head shape on the other hand exerted the most control over attack. Median SI across birds was +0 60 (range +0 32 to +0 80) for the outline probe and +0.50 (range +0 16 to +0 67) for the head shape probe Color was intermediate in its effects on preference The lack of control by the eye confirms suggestive evidence to that effect with silhouette targets [Looney and Cohen 1974] Although the eye does not influence target preference appreciably it is possible that that feature controls the locus of attacks on the head since aggressive pecks are directed at it Additional experiments concerned with the locus of attack on degraded (eg eyeless beakless etc) conspecific images are needed to evaluate that point

Without additional testing with other degraded images and combinations of images it is unknown whether specific features of the head interact to control schedule induced aggression by a quantitative rule such as the Law of Heterogeneous summation [Seitz 1940] In general the data show that the effectiveness of a conspecific target in controlling schedule induced attack is inversely related to the physical distortion of the head Removal of two relatively small but potentially salient features (eye and beak) had little effect on target preference whereas physically larger deletions and modifications of the head (outline and square head) resulted in greater but not complete preference for the intact target The inadequacy of the outlined head may in part reflect a general tendency for pigeons not to react to two-dimensional line drawings of objects as they do to corresponding photographs silhouettes or the objects themselves This is consistent with previous studies of schedule induced aggression in pigeons that have used line drawings for targets [Looney and Cohen 1974] and with Cabe s [1976]

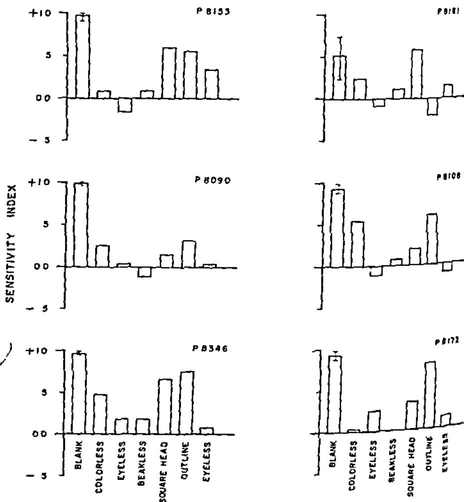



Fig. 4 Sensitivity index (SI) as a function of comparison image in order of presentation Mean and range of SI s are presented for the baseline sessions (Blank) that preceded each probe SI s for degraded comparison images are based on one day probes SI s of +1 0 0 0 and –1 0 correspond to a complete preference for the intact image no preference and a complete preference for the degraded comparison image

demonstration in pigeons of positive transfer of discrimination learning from three dimensional objects to photographs and silhouettes but not to line drawings

In summary the results suggest that the effectiveness of the head in directing attack is related to its physical integrity as a unit without regard to specific features. This may be a mass action effect (Lashley 1929) such that deletion or distortion of equivalent areas of the head (from a particular perspective) have comparable decremental effects. Such a perceptual mechanism would help to maintain the effectiveness of a freely moving conspecific target in directing attack in a complex environment.

## CONCLUSIONS

The main finding of the present experiment is that the head of a visual image of a conspecific target selectively controls aggression induced by an intermittent food schedule in pigeons. This result is consistent with those of other experiments that have found that a gross change in a target affects schedule and shock induced aggression (eg Hynan 1976) and specifically that such changes in only the visual properties of a conspecific target influence schedule induced aggression in domesticated pigeons. The generality of the present findings with respect to feral pigeons (Yoburn and Cohen 1979) and other species of birds must be determined.

The selective visual control by the target s head is of interest in its relation to similar results obtained in field studies of reproductive aggression in other species of birds. In the reproductive context the head and head related features of an intruded bird are particularly effective in initiating aggression in passerines (Smith and Hosking 1955) and Larinae (Stout and Brass 1969). This apparent similarity between target control of different types of aggression in different species of birds suggests that aggression induced by an intermittent food schedule may be closely related to reproductive and other types of aggression. For pigeons and other birds there may be a common basis for visually perceiving an opponent bird in different contexts. Hostile pigeons for example may only attend to the aspect(s) of the opponent against which the aggressive contact is ultimately made. Within-species as well as across-species comparative studies of schedule induced reproductive and other types of aggression are needed to assess this possibility.

## ACKNOWLEDGMENTS

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as stronger They are exceptionally close to their parents while bullies show sign of alienation especially from fathers

The work illustrates both the advantages and the disadvantages of this approach Professor Olweus has demonstrated convincingly that each cluster of characteristics is shared by a sizable group of boys and that there is some stability over three years in spite of changes of school and teacher (although usually not peers) He concludes that there is an aggressive personality pattern resistant to change which probably relates to home factors And perhaps there is a whipping boy personality too although this is less clear

The kind of information which one gets from rating scales and questionnaires depends of course upon the questions asked Professor Olweus has used a great deal of insight in both gathering and assessing information – insight gained no doubt from his previous studies He looks at different kinds of aggression and find bullies particularly inclined to teasing and verbal protest He deduces that bullying provides a marked feeling of superiority and supremacy also a sort of satisfaction for vague revengeful impulses He does not suggest why bullies *should find this rewarding*

But the most insightful theoretical enquiry might fail to ask all the right questions and some puzzles remain which to my mind observation might elucidate One of these relates to the apparent high self-esteem popularity and lack of anxiety of the bullies They seem in this sense well adjusted yet they are aggressive Here teachers comments are illuminating They talk of a type that enjoys being the boss cannot bear criticism cannot bear losing and likes to create conflict A few are described as having contact difficulties and making trouble in order to get attention

Although Professor Olweus regards all this as "soft data to be treated with caution it nevertheless suggests a more coherent picture of a bully We see a child trying desperately hard to prove that he has power over others the desperation is evident in his excessive reaction to opposition In my own study similar behaviour in nursery schools seemed an attempt to compensate for being (often repressively) at the bottom of the power hierarchy at home [Manning et al 1978] In circum*stances where they can present themselves as tough* powerful and successful where peers even admire and join them such children appear confident and not anxious even though underneath they may feel themselves up against it Professor Olweus has not yet analysed his findings on home backgrounds but the fact that bullies do not relate well to their parents is suggestive

Nor are teachers comments about contact difficulties necessarily at odds with the "hard fact of popularity (judged by having two or three good friends) Observation suggests that such boys associate with one or two kindred spirits (who also enjoy the fun of teasing) but still have great *difficulty in establish*ing normal friendly relationships with others

Professor Olweus has done great service in revealing some of the fact

b..llyi.. in destroying a number of myths and above all in stressing the seriousness and intra tability of the problem He argues convincingly that a bully situation is unlikely to sort itself out bullies find it rewarding and whipping boys in allowin themselves to be intimidated provide the ultimate encouragement He presses fo i tervention by the teachers both with the boys at school and with the par nts at home and he makes useful suggestions on how this might be done

I believe these recommendations should be taken very seriously It is hard for teachers to be fa ed with social work and child guidance as well as teaching but th p oblem is with us and is not likely to go away The task will not be easy and th best means of approach is uncertain I would still press for more observational evidence pe haps even guided observation by teachers and parents so that we can first come to grips with the real nature and motives of bullies and whipping boys alike

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Manning M Heron J Marshall T (1978) Styles of hostility and social in eractions at nursery at school and at home An extended study of children In Hersov I A Berger M (eds) Aggression and Anti Social Behaviour in Childhood and Adolescence Journal of Child Psychology and Psychiatry (Suppl 1) Oxford Pergamon Press

## The Evolution and Chemistry of Aggression by D D Thiessen Springfield Illinois Charles C Thomas 1976 pp xviii + 211

"It is impossible to even adequately cover the topics selected for presentation states the author in his introduction He is indeed right inasmuch as th book allows only superficial glimpses into his interesting topic

The analogy much stressed by the author that aggression is a form of competition has not received the critical in depth analysis one would expect A similar superficiality also pervades Chapters 3 to 5 containing subject matter with which th s reviewer is more familiar In the chapter on Hormone Control of Aggression " a discussion of the heterogeneous nature of the sexual process would be helpful for an understanding of the hormonal differentiation of sex and aggression It would be appropriate to weave into the story first that the subcortical regions involved in gonadotropin release from the pituitary are different from those mediat

ing sexual (aggressive?) behavior patterns second that different brain regions are sensitive to different steroids and third that anterior hypothalamic lesions do not alter testosterone secretion but do prevent mating behavior The statement b-ta tion in female mice tends to inhibit the aggression inducing effects of testosterone deserves to be expanded particularly in regard to the mechanism of prolactin re lease and its inhibition by dopamine The conclusion that high levels of proges terone may directly influence brain function and behavior or depress aldosterone formation does not contribute to an understanding of the actions of progesterone without better documentation Thus the selective uptake of progesterone into th limbic brain and the sedative effect of progesterone like agents are significant find ings in a discussion on the aggression suppressing effects of this hormone Also progesterone does not control renin secretion nor does angiotensin II a t "on the glomerulosa of the kidney Progesterone stimulates renin activity indirectly because of its anti aldosterone effect which results in natriuresis

The fact that the area of drug effects is little understood although dramatic changes in aggression have been achieved by drugs should not license the author t a write a rather uninspired chapter with so many errors and with the wrong empha sis To mention that mechanisms of action for benzodiazepines are almost com pletely unknown ignores the extensive literature on the cellular and regional central nervous action of this class of drugs In regard to aggressive behavior it would be more relevant to mention the attenuation of stress-induced noradrenalin turnover by benzodiazepines than to quote the reduction of serotonin turnover by oxazepam. The emphasis on the provocative studies [which] strongly impli cate cyclic AMP in modification of anxiety" is uncritical since the findings actually demonstrate that cAMP is not the common denominator of the effects observed In fact this hypothesis has been abandoned The selection by the author of nora drenalin and acetylcholine mechanisms involved in aggressive behavior is arbi trary Serotonin does not just play an historical role Mousekilling by rats can be inhibited by 5 HTP or pargyline and (irritable?) aggression is observed after in hibition of serotonin synthesis by p-chorophenylalanine Also anti depressants with potent serotonin uptake inhibiting properties such as chlorimipramine in hibit stimulus bound attack by cats

Granted that the effects of dopamine and noradrenalin are often *difficult to* separate one or the other amine has been selectively accumulated by the admini tration of β-hydroxylase inhibitors and 6-hydroxydopamine Depletion of bra n noradrenalin by 6-hydroxydopamine facilitates shock *induced aggressive behavior*

This book offers some interesting details which reveal the author s approach to the problem of aggression but it lacks a sharp focus on the probl ms it p r ports to discuss It also has far too many minor errors For instance Methedrine is methamphetamine (not amphetamine) and haloperidol is butyrophenone (not

phenothiazine) Also haloperidol s major effect is to block dopamine receptors Furthermore th subject index is inadequate Hence this work is of small value to the serious student

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**Hormones and Aggression Vol 1 by Paul F Brain. Montreal Eden 1977 pp viii + 126**

This little book (69 pages of text and 33 pages of references) is one of a series of Annual Research Reviews edited by David F Horrobin at the Clinical Research Institute in Montreal In an editorial introduction the reviews are described as "a new concept in medical and scientific publishing which will prove invaluable to those interested in finding the latest information on a topic The introduction continues Each topic is covered each year so that the successive annual volumes on any subject will provide a unique record of research in the field The first volume in each series while concentrating on the past year s work attempts to provide a state of the art account and also gives a bibliography of key earlier references

In view of the objectives and commitment of the entire series Dr Brain s book must be evaluated more critically than an isolated attempt to summarize a heterogeneous collection of experiments naturalistic observations and clinical reports that in varying ways and to different degrees relate to the author s concept of "aggression This concept is very broad indeed since it includes not only behavior involving overt fighting and threat but also hormonal influences on aggressive motivation " Despite much controversy concerning its final meaning Brain believes that th term aggression has some descriptive use and that it implies "(a) Intent, (b) Potential injury to another organism and (c) Emotional arousal. The following table taken directly from the text represents a personalized preliminary classification of sub human aggressions based on the perceived utility of the behavior "

A Classification of Aggressions of Sub-Human Vertebrates in Terms of Perceived Utility to the Animal

| | | |
|---|---|---|
| 1 Acquisition | *Object Acquired* | *Title* |
| | Prey | Predatory |
| | Food | |
| | Position in Hierarchy | Rank Related |
| | Territory | Territonal |
| | Mate | Mate Selected Relat |
| 2 Aversion | *Object Removed* | |
| | Predator | Maternal |
| | Conspecific | Proximity Related |
| | Painful Stimulus | Pain Induced |
| | Fear | Escape Directed |

None of *the foregoing are considered appropriate for the classification* of clinical studies and therefore these are subdivided into 1) those which assess a; gression by questionnaire or interview and 2) those in which the behavioral characteristics of groups are classified on the basis of independent measures eg the use of the XYY chromosome abnormality the use of classes of violent ; nonviolent criminals clinical assessment of psychotic and non psychotic indivi participants in sport with a violent role and participants with more passive role: etc

To the extent that he can understand them this reviewer sees little virtue in either of these taxonomic schemes which implicitly expose the absence of any unifying principles or trends that might justify the usage of aggression as a sc tifically valid concept The original fault lies in the literature itself where differ authors have applied the same term to behavioral phenomena as different as kil ing of frogs by rats ( ranicide ') and sexual exhibitionism by men *But the auth* also is culpable for he need not be captive to such vagaries and is under no obli tion to include in his summary every study or category of studies that some aut has idiosyncratically defined as dealing with aggression Unfortunately this is more or less what Brain has attempted to do

The book consists of an introduction with a statement of themes followed by a largely irrelevant single page chapter titled Hormones of Invertebrates an Aggression The next five chapters treat the evidence on vertebrates in terms of different experimental approaches For example Chapter 3 deals with effects of hormonal stimulation during early development on aggressiveness in adulthood Chapters 4 and 5 review experiments on removal and replacement of hormones and associated changes in aggressiveness Chapter 6 is concerned with natural variations in endocrine state (eg seasonal cycles sex differences strain differ

etc.) and correlated variations in aggressive behavior or aggressive motivation Chapter 7 reverses the approach and asks how engaging in aggressive behavior affects the secretion or release of hormones

The internal arrangement of Chapters 3–7 is in terms of different glands or hormones, e.g. hypothalamic releasing factors (i.e. neurohormones) pineal adenohypophysis (TSH ACTH LH FSH PRL) thyroid adrenal medulla adrenal cortex and gonads As a result the reader is confronted at points with an almost complete dearth of evidence (for example in relation to the pineal) and at others with an indigestible mass of facts such as those pertaining to the effects of castration on muricide behavior in killer rats ranicide in the same rat infanticide territorial fighting in gerbils rank related fighting or even hyperaggressivity in dogs male select on fighting in red deer genital display (threat) in squirrel monkeys and rape in man

In these five chapters the author evinces a curious tendency to strain at endocrinological gnats while swallowing psychological camels Each treatment of effects of testosterone is accompanied by separate discussions of aromatizable and non aromatizable androgens Whether testosterone must be aromatized before it can affect behavior is currently a matter of debate among experts but the distinction seems of little importance in the present book. Such recurring digressions appear particularly irrelevant in the absence of comparable concern for more important distinctions such as those between aggressive behavior and aggressive motivation

The eighth and concluding chapter deals with mechanism(s) whereby hormones influence aggressive behavior and here the reader is promised an attempt at synthesis with preceding sections of this review What the synthesis amounts to is citation of evidence indicating that behavior depends on brain function and brain function can be modulated by hormones Many of the experiments cited have nothing to do with aggression and others are only inferentially related to behavior (eg binding of labeled steroid molecules by hypothalamic neurones) As a synthesis the chapter is singularly unsuccessful

Concerted research on relations between behavior and the endocrine system is of relatively recent origin but is rapidly expanding into a new specialty that can be termed Behavioral Endocrinology Pioneers in this field came originally from a variety of disciplines including psychology zoology neurophysiology and psychiatry as well as endocrinology Only within the last two decades have we begun to train specialists with technical skills and theoretical sophistication in both endocrinological and behavioral sciences

Hundreds if not thousands of experiments have produced an impressive accumulation of empirical evidence and hundreds more are being published each year Various aspects or portions of the field continue to be "summarized" or reviewed at regular intervals and when they are competently written these summaries serve a useful though temporary purpose

The most serious need is not for still more summaries but for genuine s
theses that will attempt to bring some sort of order out of the accumulate
and help us to distinguish tho e that are significant from those that are tri

We have less need for updated bibliographies than for organized attemp
theoretical interpretation that will provide intellectual structure and guida
the understanding of existing evidence and the search for new facts

Hormones and Aggression" will not meet this need, but then it was no
in an attempt to do so A more fair and relevant criticism centers on the au
failure to face squarely his responsibility for clearly and explicitly defining
subject in such a manner that readers can assess the evidence independently
formulate alternative interpretations with possible theoretical and predictiv
sequences

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AGGRESSIVE BEHAVIOR
Volume 5 pages 317–327

# A Guide to the Literature on Aggressive Behavior

Articles relating to the general problem area of aggression are scattered throughout the whole range of specialized journals in fields from A for anatomy to Z for Zoology It is virtually impossible for a single individual to find all the articles which may bear on his particular interest Information overload is of course a problem However an even greater problem is matching the interesting article with the interested reader Aggressive Behavior will attempt to alleviate this problem by publishing a list of references in each issue The reference list will be compiled from several sources Each article listed in Psychological Abstracts and indexed under the following terms will be included

1 Aggressive Behavior
2 Anger
3 Animal Aggressive Behavior
4 Attack Behavior
5 Hostility
6 Threat Postures
7 Violence
8 Frustration
9 Conflict

Each reference will be coded according to the index terms listed above and will be listed in alphabetical order by senior author There are a large number of journals that publish articles related to aggression that are not covered by Psychological Abstracts In order to find such references the cooperation of all readers of this journal is needed If each of the several hundred investigators concerned with the problem of aggression makes a habit of contributing to the literature search section of Aggressive Behavior the search task of each of us will be made easier If in your coverage of the literature you find an article about aggression in a journal that is not regularly abstracted by Psychological Abstracts put the full reference on a 3 X 5 card and send it to the editor for inclusion in this section

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5 Hostility 6 Threat Postures 7 Violence 8 Frustration 9 Conflict

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AGGRESSIVE BEHAVIOR
Volume 5 pages 329–339

# Agonistic Rank, Aggression, Social Context, and Testosterone in Male Pigtail Monkeys

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Two groups of pigtail monkeys were merged a third was formed, and individual males were introduced into a group in a series of experiments examining the effects of social context upon agonistic rank, aggressive expression and testosterone levels In the first experiment two heterosexual groups, containing adult males unfamiliar to the other group were merged The two groups fought, and the smaller group was defeated The alpha and beta males of the defeated group were singled out for repeated attack and both showed significant drops in circulating levels of testosterone Both males were removed from the group during the first day but testosterone levels did not recover to baseline levels for several days. The alpha male of the victorious group on the other hand, showed a significant rise in testosterone which was apparent only on the day following the merger

In order to study the influence of previous social familiarity on male reception into a group another group was formed by removing males from the victorious group and placing them in a separate enclosure The males in the new group established a dominance hierarchy unrelated to their previous social ranks with one another Three months later each of the six adult males remaining in the parent group was individually introduced into the new group for one day or less.

Each of the males introduced into the new group accepted a social position at the lower end of the dominance hierarchy without regard to his previous rank relationships with the host males when they were all in the parent group

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Even the alpha and beta males of the parent group were relegated to low rank positions in the new group despite having ranked over each of the host males since birth

In contrast to the aggression directed at the unfamiliar males in the first experiment a minimum of aggression was directed to the familiar males introduced into the new group in the second experiment Although the males introduced accepted low social ranks it appeared that each was readily integrated into the group with a minimum of aggressive interaction during the time he was scheduled to remain in the group There were no significant changes in circulating levels of testosterone in any of the males during the introductions of familiar males to one another

Key words dominance determinants, group formation testosterone pigtail monkeys, familiarity and aggression

## INTRODUCTION

In studies of individual introductions of rhesus monkeys (Macaca mulatta) to established groups we have reported consistent defeat of the newly introduced animal often accompanied by a depression of circulating levels of testosterone in male subjects [Bernstein et al 1974 Rose et al 1972] Similarly the merge of rhesus monkey groups has resulted in the defeat of one group by the other with high ranking males in the defeated group showing plasma testosterone depressions whereas the victorious alpha male showed a brief but dramatic rise in hormonal level [Bernstein et al 1974 Rose et al 1975] In a few rare cases when introduced individuals were not defeated by the host group successful defendants showed hormonal rises [Bernstein et al 1974] whereas mere membership in the victorious group did not produce hormonal rises in resident males not participating in vigorous successful attacks against intruders

The present study was designed both to test for the generality of these findings to a second macaque (Macaca nemestrina) and to dermine what influence previous social familiarity has upon the reception of an intruder into a group If in fact dominance was an individual attribute expressed in social relationships the a knowledge of relative ranks in a previously long-established social relationship should allow for prediction of ranks after the introduction of animals into a new social setting If on the other hand rank positions were a reflection of the current established social order then past histories of rank relationships would not influence the new rank order established in a new social situation If individual familiarity due to past association had no influence on the reception of a newcomer then both social and hormonal responses to introductions should be the same for intruders regardless of past associations with animals in the host group If on the other hand such associations did influence the receptions received there should be perceptible differences in receptions between familiar and unfamiliar animals introduced into a new social group

## METHOD

### Unfamiliar Male Introduction

Two groups of pigtail monkeys were used in the first experiment The first consisted of four adult males (Ob Z Ya C) four females and an infant whereas the second contained approximately 50 animals of all ages and both sexes including six adult male subjects (Z Kb Hb Lb Ec Tb) Both groups had been maintained undisturbed for at least six months prior to the period of study in outdoor compounds with access to indoor quarters

The groups were merged by releasing the smaller group (group I) into the 30 m square compound containing the larger group (group IIa) The behavior of the ten males was observed and systematically scored using a standard vocabulary during the merger and for several hours thereafter Additional observations were made during the following days

Blood samples were drawn from each of the ten males six and four days prior to the merger and on the morning of the merger and on the first third and ninth days after the merger at approximately 1 000 hours in each instance The collection of blood samples and the analysis of testosterone by radioimmunoassay were conducted using procedures that have been previously described [Gordon et al 1976] All assays were run in duplicate and the coefficient of variation of duplications was reported as 2 18% with sensitivity at 5 pg and blank values not significantly different from zero

### Familiar Male Introduction

The second experiment was conducted ten months after the first Five adult males from group IIa (Hb Rb Fc Lb and Tb) two males from group I (Z and C) and several females were placed in another 15 m square compound to form a new group group III These animals formed a new dominance hierarchy with Hb as alpha Male Z failed to be integrated into the group and was removed Dominance ranks were determined using the method of dyadic analysis of the directionality of agonistic encounters

Three months after group formation the females were removed and six other males from group IIb (Kb Q Lc Yb Ya Zb) were removed one at a time placed in an individual cage for one week introduced to group III for one hour returned to their individual cage for another week and then returned to group IIb (Group IIb was the remainder of group IIa after III was formed ) Removals from IIb were done at two week intervals so that only one animal was out of the group at any time The order of introduction was not related to the rank of the animals which had changed since the removal of the animals to form group III so that Q who had been the alpha male of the group was now second to Kb

The experiment was thus divided into four conditions with three bloc drawn in each condition Baseline draws in the group took place minus 6 minus 4 days and at the time of removal During the week in the individu prior to introduction in the week following introduction and in the wee return to the group blood samples were obtained at +24 hrs +72 hrs an week Behavior was scored during the first hour of introductions and sum ized into 20 minute blocks Data collection in this case used the introduc mal as focal subject

A summary of male subjects used in each of the two experiments and manipulation procedure appears in Table I

## RESULTS

### Introduction of Unfamiliar Males

Shortly after the animals in group I were released into the compound t housed group IIa fighting broke out between the dominant males of th t groups Q the alpha male of the larger group led his group and vigorously ed Ob and Z the alpha and beta males of the smaller group Both Ob and Z ceived high levels of noncontact and contact aggression and displayed redu aggression to the subordinate males of their own group The attacks on Ob Z were persistent and severe and both animals received multiple wounds ar had to be removed from the compound within two hours after being introd

The other two introduced males Ya and C received comparatively less contact aggression and very little contact aggression and engaged in nonag social interactions with members of group IIa In fact within a few hours af the introduction Ya repeatedly mounted a female and was no longer involve agonistic episodes C was the only introduced male to exhibit more noncont aggression than he received and this was directed primarily toward three gro IIa males (Kb the beta male of group IIa) Hb and Rb Although C generally avoided group IIa members he would threaten any animal approaching the co ner in which he spent most of the time C was removed during the night for protection and on return to the group fought briefly with Q He was removed again during the second night and was attacked by Kb on return defeated an removed to avoid further injury Ya was the only male to remain with group I and of the four males form group I Ya was the only one who had lived in gr IIa within the last five years

The two males who were clearly defeated by the larger group Ob and Z each showed a dramatic fall in testosterone level The mean measures and the three follow up measures are shown in Table I A z score was calculated for all follow up measures to test for significance Figures 1 and 2 express testosteron concentrations as the percent of the mean value for the period of the study an

ABLE I Adult Male Subjects in Each of the Study Groups

| Unfamiliar Male Experiment | | |
|---|---|---|
| Subjects | | Procedure |
| roup I | Group IIa | Groups I and IIa merged |
| Ob | Q | |
| Z | Kb | |
| Ya | Lc | |
| C | Rb* | |
| | Lb* | |
| | Yb | |
| | Hb* | |
| | Zb | |
| | Ec* | |
| | Tb* | |

conclusion males were drawn from group I and group IIa to establish group Asterisks designate males forming group III Males Ob and Z of group I were t used in the second experiment

| Familiar Male Experiment | | |
|---|---|---|
| Subjects | | Procedure |
| oup IIb | GroupIII | |
| Kb | Hb | Each group IIb male was individually introduced to group III for 24 hours or less |
| Q | Lb | |
| Lc | Rb | |
| Ya | Tb | |
| Yb | Ec | |
| Zb | C (removed during first trial) | |

oth Ob and Z show falls to less than 20% of mean values following introduction scores of 5 9 and 2 8 are significant P<0 001 and P<0 01 respectively ) The hor onal levels of the two undefeated males C and Ya fluctuated during the period f the study but all of their measures following introduction were within one tandard deviation of their mean baseline values (Defeat was defined as having ccurred when the subject crouched emitted submissive signals and no longer esponded with aggression to aggressive signals or attack or took any active steps o fend off attack )

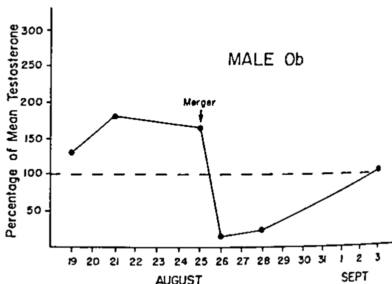



Fig 1 Testosterone levels of alpha male of the defeated group when two gr were merged All points are expressed in terms of the percent deviation fror grand mean Group merger occurred on 25 August immediately following th last baseline measure

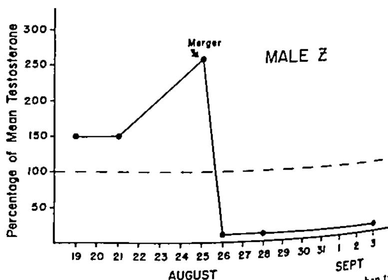



Fig 2 Testosterone levels of the beta male of the defeated group when two groups were merged See caption Figure 1

The alpha male of group IIa Q who led the attack on the group I males showed a brief rise in testosterone (see Table II and Fig.3) to a value almost two and one half times g a er than his mean value for the period of the study (z score of 9 0 significant P < 0 001 ) Neither the beta male Kb nor any subject male in group IIa w h the exception of Ec showed a significant hormonal rise on the day following the introduction Male Ec did show a significant 300% rise in testosterone although he was only observed to participate in a few agonistic episodes (z score 83 2 significant P < 0 001 ) Significant drops in Hb s levels and the rise in Kb s levels did not seem to relate to the group merger but rather to events within group IIa itself

**Introductions of Familiar Males**

In the second experiment the social order of group III was maintained during e ch of the introductions of group IIb animals Despite the fact that both Q and Kb had b en dominant over all of the group III males since their births and up un til th time they were removed from group IIb all of the group IIb males yielded immediately to Hb as the alpha male in group III There were no massed attacks against any of the six familiar intruders although signs of tension [see Maxim 1978a b] such as yawning and puckering [Bernstein 1970 elsewhere described as LEN Kaufmann and Rosenblum 1966 or jaw thrust Bobbit and Jensen 1964] were observed throughout the first hour Virtually no aggression was observed during the introduction of Lc who (as also with Ya and Zb) was quietly accepted

Table II Testosterone Values (ng/ml) of Males Prior to Group Merger and Changes

| Subject | Mean baseline | +24 hours | +72 hours | +1 week |
|---|---|---|---|---|
| Group IIa | | | | |
| Q | 4 36 | 14 20* | 6 89 | 3 35 |
| Kb | 17 17 | 16 34 | 24 99 | 32 00 |
| Hb | 17 99 | 10 1? | 17 95 | 12 12 |
| Lb | 24 34 | 34 14 | 23 03 | 23 93 |
| Tb | 2 98 | 1 43 | ? 96 | 1 46 |
| Ec | 3 69 | ?3 ?3 | 3 83 | 5 67 |
| Group I | | | | |
| Ob | 26 08 | ? 58 | 4 18* | 18 19 |
| Z | 19 25 | 1 23 | 1 24 | 1 37 |
| C | 16 08 | 26 92 | 13 16 | 19 78 |
| Ya | 8 62 | 3 .7 | 3 02 | 6 47 |

Significant z scores at P<0 005

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# Attack and Defensive Behaviors in the Albino Mouse

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Attack by dominant male colony mice on intruders included chasing and lateral attack behaviors, while the corresponding intruder behaviors were flight boxing and checking Both of these are similar to the attack and defensive behaviors of colony rats and intruders. However mice did not show a significant constraint on bites to ventral areas and the rat defensive behavior of lying on the back which is effective because of this constraint was rare the corresponding on top behavior of attackers was almost absent in mice These findings strongly support the view that intraspecific attack and defensive behaviors and target sites for bites are interrelated factors facilitating effective but nonlethal agonistic interactions in muroid rodents

Key words fighting aggression attack sites defense mouse

## INTRODUCTION

Several independent analyses of attack and defensive behaviors in different animal species [Geist 1971 Blanchard et al 1977a Blanchard et al 1978] suggest that intraspecific fighting has a *distinctive topography* which is based on the adaptive value of specific attack and defensive acts or strategies In Rattus norvegicus albinus) – the common laboratory rat – the following factors appear to operate in shaping the main features of attack and defense The basic factor is a nonrandom distribution of bite targets on the body of an attacked conspecific such that bites are seldom made on the ventral trunk When bites are made in this area they

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generally result in damage to vital organs and extrusion of intestines or at the very least a very high risk of peritonitis Death tends to follow quickly even from a single bite Thus a tendency for attackers to avoid such bites is obviously adaptive when there is a substantial probability that the attacker and defender rats are closely related a situation which may be normative for colonial Rattus norvegicus groups The constraint on bites to the ventrum is at least partly independent of the behavior of the bitten animal and may extend to total cessation of biting when only the ventrum is available to be bitten [Blanchard et al 1977b]

The major defensive reactions of rats consist of boxing in which the defender rises or sits on hind limbs facing the attacker and lying on the back Both of these reactions may be interpreted as adaptive because the primary area exposed to the attacker is the ventrum which involves little danger of direct bites while the more vulnerable back sites are concealed In addition boxing is an especially effective tactic because protection is afforded by the use of the mystacial vibrissae which are fanned forward and interposed between the defending rat s head and the snout of the attacker

The topography of attack is also related to the attacker s tendency not to bite the ventrum and to the specific defensive reactions used by the attacked animal Dominant colony animals tend to make lateral attacks against boxing defenders crowding with the side of the body against the defending rat From this position it is easy to make a quick forward lunge around the defender bringing the attacker s snout into contact with the prime bite target the defender s back When the defender is lying on the back the attacker stands on top of it usually at right angles to the line of the defender s body and darts around or over the ventrum to bite at side and back areas as these become exposed

This pattern of target sites defender behavior and attacker behavior forms a nexus in which each activity is functionally related to other major acts in the system Geist [1971] has suggested a similar set of relationships in mountain sheep in which target sites and fight topography combine to produce a system of intraspecies agonistic behavior which permits victory and defeat without serious risk of death to either combatant In bears there may be differences in the topography of agonistic behavior and target sites of bites and blows during dominance fights as opposed to disputes arising over food the dominance fights involving bites and blows to the heavily furred neck and ruff area [Blanchard et al 1978]

If the pattern obtained in rats is typical of intraspecific agonistic behavior in higher animals it should be comparatively easy to detect a close functional relationship of target sites and attack and defensive behaviors in other species Moreover in the case of species fairly closely related to the rat it seems likely that some similar or identical patterns might have emerged from their common evolutionary background The present investigations therefore assess the topography of attack and defense and the sites of bites and lesions in mice and the functional relationships among these factors in this species in order to evaluate the across-species generality of the agonistic pattern described in the rat

The colony situations in which these behaviors are examined were designed o provide a polarization of attacker and defender behaviors [Blanchard et al 977a] In these situations the dominant colony animals display a pattern of tta k behaviors that shows almost no overlap with the defensive behaviors dis layed by intruders They therefore provide an opportunity to experimentally ;rify the categorizations of attack and defensive behaviors suggested by Scott 1947] or of attack and submission as suggested by Ginsburg et al [1942]

## (PERIMENT 1

### ethods

Subjects The colony and intruder animals were albino Swiss Webster mice ed locally from stock obtained from Simonsen Laboratories Six colonies were ablished by placing one male and two female mice in each colony compartment ese animals had been weaned at 21 days of age and housed with like sex litter tes until placed in the colonies at an average age of 150 days When formal ony testing was initiated the male mice of these colonies averaged 176 days of and 41 gm in weight The six intruder mice used in the filmed sessions averaged 9 days of age with a mean weight of 40 gm The intruders had been weaned at out 21 days of age and housed with male littermates until 20 days before the dy at which time they had been separately housed in individual metal mouse es (24 X 20 X 20 cm)

Apparatus The colonies were housed in translucent amber-colored plastic es measuring 38 X 32 5 X 16 5 cm covered with a wire mesh top A layer of od shavings was used as bedding and was changed each week Food and water re continuously available

A Braun Nizo camera and Kodak Ektachrome Super 8 film were used to ord the agonistic sequences in the first experiment Supplemental lighting for se films was provided by a 100 W bulb in a reflector

Procedure When the colonies were formed each colony male was marked h Fuschan dye to facilitate identification during intruder tests Three days r the colony was formed the first of a series of preexperimental intruders was ced in each colony for a five minute period Within two weeks of receiving uders on every third day a steady base line for attack latency bites and ons on the intruders as well as other attack behaviors was obtained in each ony The formal colony intruder sessions which were filmed took place on 18 after the initial intruders were introduced

For all intruder sessions the females and any pups in each colony were noved prior to the introduction of the strange mice During the formal colony ions an intruder was introduced into the colony cage now occupied by only colony male Filming at 24 frames per second was initiated with the first seen and continued for the next 180 seconds

The films were examined in slow motion and also on a frame by frame ba[illegible] on a Goko film editor The behaviors of both attacker and defender were classi fied by an experienced rater and their durations (or other appropriate measure ments) were obtained The behavior categories recorded were the following

**Attack Behaviors**

1 Straight approach moving in a straight line toward the other animal
2 Circle approach moving in the direction of the other animal via an arc like path and approaching to within 5 cm
3 Chase pursuit of a fleeing opponent If either a straight or a circle approa[illegible] resulted in flight of the approached animal and the approach continued c[illegible] was scored
4 Biting frequency duration and the site on the opponent which was bitten were all recorded
5 Bite chase the bitten animal flees and the biter maintains his bite grip and moves with the fleeing animal
6 Lateral attack an animal moves laterally toward or in a tight circle around and within 2 cm of its opponent
7 On top of an animal stands over or on top of its opponent

**Defensive Behaviors**

8 Flight moving away from an approaching opponent
9 Freeze periods of immobility lasting more than 1/3 second
10 Checking turning to maintain one s orientation toward the attacking anima at a distance of less than 5 cm but greater than 1 cm
11 Box erect on the hind limbs with orientation toward the opponent
12 On the back lying on the back
13 Turn to face a turn to face the other animal which is in close contact

In addition to these categories characterized as attack behavior or as defensive behavior on the basis of a functional analysis of fighting in rats (Blanchard et al 1977b) a final category of Other included such activities as brief periods of immobility (less than 1/3 second) exploration self grooming drinking etc

After filming intruders were removed from the colony enclosures and sacrifi[illegible] with an overdose of pentobarbitol sodium (Nembutal©) They were then covered with a commercial depilatory (NEET® hair remover) and refrigerated for 24 hours Depilatory and body hair were then removed and lesions counted and catalogued by the site of damage Pilot studies indicated that new lesions could readily be distinguished from lesions more than a week old so the fresh lesions counted on intruders could reasonably be attributed to injuries received during the colony session Lesions on the colony males however could have been made at any [illegible] Therefore observations of intruder bites on the colony males were used as th[illegible] so[illegible] index of target preference in these mice

Statistical analysis of results involved t tests for m asures meeting the usual requirements for parametric analysis. Other behaviors usually those which were very infrequent and not normally distributed in one or both groups were analyzed by means of Mann Whitney U tests.

Results

Attacker versus defender behaviors (film analysis) Film analysis of the intruder–colony mouse interactions indicated a consistent difference between the behaviors of these two groups of animals as well as the sites on which they bit their opponents Table I presents the proportion of time that colony mice or intruders spent in each of the measured behaviors As this table indicates colony males spent reliably more time in straight approach circle approach chase bite-chase and lateral attack behaviors than did the intruders (Mann Whitney U test U = 0 N = 6 and 6 P < 0 001 in each case) Although on top behaviors were somewhat more common for the colony mice this behavior was seldom seen in either group of mice

TABLE I Percentage of Time Spent in Given Behaviors for Colony Male Mice and for Conspecific Intruders in the Colonies

| | Mean percentage times[a] | |
|---|---|---|
| Behaviors | Colony males (N = 6) | Intruders (N = 6) |
| Attack behaviors | | |
| Straight approach | 6 1* | 0 1 |
| Circle approach | 14 4*** | 0 1 |
| Chase | 12 8 ** | 0 0 |
| Bite–chase | 5 4 * | 0 0 |
| Lateral | 10 3** | 0 1 |
| On top | 1 4 | 0 7 |
| Active defense | | |
| Boxing | 4 8 | 23 0 |
| Checking | 0 0 | 5 2 * |
| Turn to face | 0 1 | 1 4 |
| On the back | 0 1 | 0 7 |
| Flight | 3 4 | 25 4 |
| Freezing | 17 5 | 17 3 |
| Roll-tumble | 0 2 | 0 6 |
| Other | 19 8 | 29 8 |

[a] In each case the asterisks designate the group showing the higher level of that behavior

* Colony male–intruder differences reliable at 0 05 level
** Reliable at 0 01 level
*** Reliable at 0 001 level

and the difference was not significant (U = 6 N = 6 and 6 P > 0 05) The intruders spent reliably more time boxing (t = 2 56 N = 10 P < 0 05) checking (U = 0 N = 6 and 6 P < 0 001) turning to face (U = 1 N = 6 and 6 P < 0 01) and in flight (t = 6 15 N = 10 P < 0 001) than did the resident mice

This division of behaviors for mouse colony animals versus intruders obviously corresponds well to the division of behaviors as attack or defensive on the basis of colony male and intruder behaviors in rat colonies It also agrees with the categorizations of Scott [1947] and of Ginsburg et al [1942] All five of the behaviors for which colony mice were higher than intruders were similar or identical to those designated as attack behaviors in the rat studies while all of the four intruder mouse behaviors were typical also of rat intruders Of the behaviors which did not differentiate the present resident and intruder mice two (freezing and on the back) had been designated as defensive on the basis of the rat results while a third on top was an attack behavior All of these behaviors occurred at a much lower level in mice than in rats a finding in agreement with the finding of Grant et al [1963] of relatively little lying on the back (which they term full submissive posture ) or standing on top ( full aggressive posture ) in the mouse The remaining categories (roll tumble and other) did not differentiate the behaviors of resident animals and intruders in either rat or mouse colonies Thus the present results suggest a very similar array of attack and defense behaviors for mice and rats with the exception that freezing and on the back behaviors typical of intruder rats appear not to be so typical of mice and the corresponding on top behavior of attacking mice is similarly reduced

Additional evidence of similarity of attack and defensive patterns in mice and rats is provided by the sites at which bites occurred for colony and intruder mice presented in Table II As this table indicates much more biting was typical of the colony male mouse than of the intruder (t = 3 51 df = 10 P < 0 01) In addition the sites bitten on the opponent animal also tend to vary systematically with the

**TABLE II** Percentage of Bites as Given Target Sites

| Target site | Bites by colony males | Bites by intruders |
|---|---|---|
| Anterior back | 13 2 | 8 0 |
| Posterior back | 64 7 | 7 8 |
| Hind limbs | 7 3 | 10 [illegible] |
| Front limbs | 1 5 | [illegible]9 0 |
| Tail | 0 3 | 0 0 |
| Head | 1 8 | 37 4 |
| Abdomen | 8 6 | 6 5 |
| Thorax | 2 6 | 1 1 |
| Mean number of bites | 64 0 | 13 3 |

status of the biting animal Colony male mice made the majority of their bites in the posterior back area of the intruder while the intruders bit the head of the colony animal Both posterior back bites (t = 8 74 df = 10 P < 0 001) and head bites (U - 0 N = 6 and 6 P < 0 001) were reliably different for the two groups of mice Colony males also made fewer bites to the ventral body surface (abdomen and thorax) than they did to the dorsal body surface (anterior and posterior back) (t = 4 54 df = 5 P < 0 01)

Both of these findings — a tendency for colony animals to bite dorsal areas of the intruder and for the intruders to make their many fewer bites on the head and about areas of the colony animals — agree with the patterns of bites seen in interactions of colony and intruder rats Moreover the finding that ventral areas are less often bitten than dorsal areas is also similar to the findings of rat encounters Some differences do appear however First the primary target for bites by colony males on intruders is the anterior back rather than the posterior back site favored by mice Although few ventral bites were seen in the present situation there were somewhat more of these than are typically seen in rat encounters As a general summary however it is apparent that the present mouse data generally repeat those of a systematic distribution of bites in attack and defense by rat colony animals and intruders

**Interaction of attack and defensive behaviors of the mouse** Table III presents the proportion of bites preceded by a given behavior of the bitten animal or of the animal making the bite for bites by both colony males and intruders As this table indicates most of the bites made by colony males on intruders occurred while the bitten animal was fleeing Flight was clearly an extremely dangerous behavior for the intruder as nearly 60% of bites were made during intruder flight although such flight accounted for only about 25% of interaction times Thus although flight might be expected to result in the removal of the intruder in more natural situations it is obviously a poor defensive behavior in the inescapable colony situation

Boxing was also a dominant intruder behavior occurring during 23 0% of the timed periods but it was associated with a much lower rate (14 1%) of bites received The other major intruder behavior freezing was associated with an even lower level of bites It might be noted however that such a comparison does not unequivocally indicate the value of defensive behaviors in thwarting bites since freezing and some other activities ( Other ) observed primarily occurred while the attacker was at a distance or temporarily failing to press its attack

The three major behaviors of the attacking animal which were most clearly associated with bites made by these mice on the intruders were chasing the lateral attack and approaching (straight plus circle) Of these behaviors the lateral attack and chasing were especially likely to result in a bite since they occupied only 13 1% of the times analyzed but resulted in nearly 60% of bites made by these animals

**TABLE III** *Percentage of Bites Preceded by a Given Behavior*

| | Colony male bites | | Intruder bites | |
|---|---|---|---|---|
| Behavior | Colony male preceding behavior | Intruder preceding behavior | Intruder preceding behavior[a] | Colony male preceding behavior |
| Approach (straight + circle) | 12 50 | 0 00 | 0 00 | 1 25 |
| Lateral | 17 71 | 0 26 | 0 00 | 10 00 |
| On top | 5 21 | 1 56 | 3 75 | 2 50 |
| Chase | 40 62 | 0 00 | 0 00 | 5 00 |
| Bite | 4 42 | 1 30 | 0 00 | 73 75 |
| Box | 4 43 | 14 06 | 11 25 | 0 00 |
| Checking | 0 00 | 0 00 | 5 00 | 1 87 |
| Flight | 0 00 | 59 37 | 63 75 | 2 50 |
| On the back | 2 04 | 3 39 | 1 25 | 2 50 |
| Roll tumble | 1 04 | 1 30 | 3 75 | 0 00 |
| Freeze | 0 00 | 3 91 | 0 00 | 0 00 |
| Other | 10 94 | 10 15 | 10 00 | 2 50 |

[a] Since an intruder facing away from his opponent must necessarily engage in a turn to-face movement in order to bite that category was omitted from this analysis Where applicable the category of behavior preceding the turn to face movement was counted as preceding the intruder bite

The behavioral antecedents of bites made by the intruding mice on the colony animals were even clearer Nearly two thirds of intruder bites occurred just after the intruder had been fleeing and nearly 75% of all bites occurred just after the colony male had bitten the intruder Thus while bites on intruders occurred after sequences of attack behaviors by the colony animals and defensive actions of the intruders *bites by intruders occurred just after the intruders had been bitten by* the attacking colony males

**Attack and defense patterns in mice and rats** This pattern of findings provides overwhelming evidence of a basic similarity of mouse and rat intraspecific agonistic behaviors The exceptions to this pattern are also systematic Mice in comparison with rats appear to have a less definite preference for dorsal target sites for bites Also intruder mice show much reduced levels of lying on the back and of freezing than do intruder rats while attacking mice show a reduction in the corresponding on top behavior Since the strategic value of lying on the back depends on a constraint on bites to the ventrum these findings may all reflect the comparative lack of such a constraint in mice Experiment 2 therefore examined bite targets on anesthetized mice

## :XPERIMENT 2

Experiment 2 was designed to obtain information on the possibility of a limita on on bites to the ventrum of conspecifics in mice which is independent of the havior of the attacked animals

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*Subjects* The colony animals were those used in Experiment 1 and the intru rs were 24 male mice of this same strain averaging 148 days of age with a an weight of 40 gm These intruders had been reared under conditions similar those of the intruders in the first experiment

*Apparatus* The colony cages were those used in Experiment 1 Also a platform s used to secure some of the anesthetized animals This was an X shaped section 0 6-cm plywood with its rectangular outline measuring 20 X 15 cm A 2 5 cm t was fastened to each of the four exterior corners of the platform to which limbs of the anesthetized animal could be fastened by means of rubber bands

*Procedure* The sites of bites and wounds were determined for four groups of specific intruders into the mouse colonies The first group was unanesthetized unrestrained – equivalent to the mice used in the film analysis The remaining e groups were all heavily anesthetized (90 $m_g$/kg sodium pentobarbitol) the e in one of these groups were not tied down but simply placed on their sides h colonies The remaining anesthetized mice were tied to the X shaped plat n either with the dorsal surface exposed or with the ventral surface exposed intrud rs were placed individually into one of the six colonies the order of entation of the mice of the four groups being varied according to a predeter ed random order All stimulus mice were used for a single session The sessions : six minutes in length beginning with the first bite of the colony male on the ider

After being removed from the colonies all intruders were sacrificed and NEET used to remove their hair Lesions were then counted and categorized by site

### ılts

*arget sites on dorsally and ventrally presented intruder mice* Table IV presents nean number of lesions on each type of stimulus animal plus the percentages sions at each target site for the different stimulus groups. As this table indi colony mice made reliably more bites at unanesthetized intruders than at hetized but unfixed animals ($t = 4.03$ $df = 5$ $P < 0.01$) or at the ventrally nted group ($t = 3.55$ $df = 5$ $P < 0.05$) Although considerably fewer bites made at the fixed dorsal group than at the unanesthetized group this dif ce was not statistically significant ($t = 1.60$ $df = 5$ $P > 0.05$) Within the anesthetized stimulus groups there were no reliable bite differences although

TABLE IV Proportion of Lesions at Given Loci for Three Anesthetized a[illegible] One Unanesthetized Stimulus Mouse Groups

| | Locus | | | | | | |
|---|---|---|---|---|---|---|---|
| | Head | Anterior back | Posterior back | Limbs | Thorax | Abdomen | Tail |
| Unanesthetized | 4 5 | 14 9 | 54 1 | 13 2 | 3 1 | 9 [illegible] | 0 9 |
| Anesthetized | | | | | | | |
| Unfixed | 37 9 | 12 5 | 17 9 | 12 8 | 8 7 | 9 5 | 0 [illegible] |
| Fixed dorsal | 68 1 | 16 6 | 5 9 | 11 6 | 0 0 | 1 1 | 0 6 |
| Fixed ventral | 70 6 | 0 0 | 0 0 | 3 3 | 20 9 | 5 2 | 0 0 |

more than twice as many bites were made at the dorsal stimuli than at the [illegible] presented animals

Comparison of the distributions of bites on the bodies of the three anest[illegible] groups in comparison to the unanesthetized group indicates a shift from th[illegible] sites most often bitten on unanesthetized intruders to a consistent tendenc[illegible] bite at the heads of anesthetized animals This pattern is perhaps even more [illegible]nounced in rats where about 75% of bites on anesthetized conspecifics are [illegible] on the head [Blanchard et al 1977b] The differences in head bites to unan[illegible]ized as opposed to anesthetized mouse targets were reliable (U = 0 N = 6 a[illegible] P < 0 05 for each comparison) It seems very likely that this difference is att[illegible]butable to protection of the head by active use of the vibrissae in unanesthet[illegible] mice or to active avoidance of the snout and teeth of the opponent animal b[illegible] mice attacking unanesthetized mice

However in contrast to the pattern obtained in rats bites at the ventrally presented stimulus mice were frequently made on ventral trunk areas S[illegible] h[illegible] accounted for 36% of all bites seen in this group a figure equivalent to the [illegible] of bites made to back areas in the dorsally presented stimulus group It shoul[illegible] be noted that fewer (though not reliably fewer) total bites were made at the ventrally presented mice but these data certainly do not su[illegible]est any limitatio[illegible] of ventral bites in mice that is equivalent to that seen in rats

Another comparison relevant to this point may be found in the numbers o[illegible] bites to ventral as opposed to dorsal trunk sites on the mice that were una[illegible] ized but not fixed Since the attackers could turn these animals freely to s[illegible] targets the finding of 22 8% dorsal trunk bites versus 13 7% ventral bites may [illegible]est some preference for the dorsal targets It does not however imply a[illegible] eff[illegible]tive constraint on bites to the ventral areas

These data then suggest that of the two factors postulated to influence the form of defensive behavior in rats one is also effective in mice while the other is less important Defending rats fan their vibrissae forward and interpose these between the attacker s snout and their own vulnerable head (and sometimes body) If the vibrissae are removed or even anesthetized this protection is reduced and more bites especially to head areas result [Blanchard et al 1977c] The present finding that anesthetization produces a striking increase in bites of a mouse to the head of a conspecific clearly suggests that the vibrissae and their use serve a similar protective protective purpose in mice An additional and perhaps even more important mechanism that protects the head of unanesthetized mice is the danger of retaliatory biting An attacker bite toward the head of a defender involves a substantial risk that the defender will retaliate by biting the attacker s snout

Since the head of the attacked mouse is protected by both of these mechanisms it is extremely adaptive for a defensive mouse to use the boxing defense to a specific opponent During boxing the defender presents its head vibrissae and teeth to the teeth of the attacker while concealing its own back An upright stance also permits the quick pivot necessary to follow an attacker s lunge around toward the defender s back Thus the adaptive value of boxing and of the circling and lateral attack which is the usual attacker response to a boxing defender appears to be related in both mice and rats to the relative invulnerability of the defender s head

While a mouse is lying on the back however maneuverability of the head is very limited Thus use of the vibrissae and the danger of retaliatory biting is limited when an animal is in this position This tactic is therefore quite dangerous in terms of risk of bites unless it is extremely unlikely that even an unprotected ventral area will be bitten In rats almost no biting of unprotected ventral sites occurs this constraint therefore makes the tactic of lying on the back effective In mice a decrease in lying on the back is understandable in the context of sharply reduced effectiveness of limitations on bites to the ventrum

The present results therefore suggest that of the two major phenomena which shape attack and defensive behaviors in the rat one is also important in the mouse The other a constraint on bites to the ventrum is not of major importance It is not clear why mice should be so different from rats in terms of readiness to bite the ventral area of a conspecific Perhaps this is related to the degree to which these species typically live in closely related groups Another possibly related factor is that mouse wounds tend to be punctate and therefore less serious than the tearing wounds made by rats thus making a constraint on ventral bites less necessary in mice

The significance of these findings however is not just that mice resemble or fail to resemble rats in their agonistic behaviors What is significant is that these

data provide additional and unequivocal support for a view that the topography of each specific agonistic behavior for a given species is a predictable compone- of a pattern linking behavior body structure and the social and physical envir ment of that species If one component of this pattern changes such as the co straint on bites to the ventrum of a conspecific then this alters the adaptive fu tion of other components in the system in this case the defensive behavior of lying on the back and the on top attack None of these three differences in the agonistic behaviors of mice as compared to rats is understandable in isolation l in combination they provide insight into the adaptive function involved in the evolution of a complex behavior system

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AGGRESSIVE BEHAVIOR
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# The Reinforcing Value of Several Types of Aggressive Behavior A Review

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Field observations of "surplus killing" and laboratory studies of operant performance rewarded by prey killing opportunities suggest that predatory behavior is positively reinforcing Similarly both repeated encounter and operant performance studies suggest that intraspecific aggression can be positively reinforcing for successful aggressors. While a few studies suggest that defensive aggression under aversive conditions may also be positively reinforcing it appears that when appropriate response modes are available escape and/or avoidance are preferred to attack Studies of the reinforcing properties of aggression-eliciting brain stimulation are in general agreement with these conclusions, but methodological problems with these latter observations render them less compelling

The progressive escalation of aggression seen in "warm up effects" of birds and fish "priming effects" of mice and ecstatic violence of humans may be analogous processes based on the positively self-reinforcing characteristics of some kinds of aggression The transient reductions of aggression which appear as refractory periods and satiation effects in a variety of species may reflect temporary reductions in the reinforcing value of aggression All these temporal effects must be considered in the evaluation of experiments on the reinforcing value of aggression More generally it is possible that these temporal fluctuations reflect the operation of common motivational processes (aggressive states) which regulate overt aggression by changing its reinforcing value

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## INTRODUCTION

The rediscovery of predatory [Myer 1964] and shock elicited defensive aggression [Ulrich and Azrin 1962] in laboratory rats facilitated by the sim taneous popularization of ethological views [eg Lorenz 1966] has prompt renewed and continuing interest in ag_ression among laboratory investigator animal behavior A general if not complete consensus has arisen that several quite distinct forms of aggression may be distinguished on the basis of speci typical response topography and a variety of other indicators [e Moyer 19 However the precise number and exact characterization of these forms is stil matter of dispute The examples chosen for this paper can be cate orized re latively unambiguously as either predatory intraspecific or defensive (irritat aggression [cf Moyer 1976]

That aggression may be used by animals as an operant to attain other e eg acquisition of resources or removal of a threat is not surprising However number of the recent laboratory studies have also provided experimental ev which supports the ethological contention that under appropriate circumsta performance of some of these forms of aggression is positively reinforcin in of itself That successful aggression can be an intrinsically rewarding experien for the aggressor is a striking and to some counterintuitive proposal Some c studies demonstrating the positively reinforcing aspects of aggression per se h already been reviewed [eg Johnson 1972 Baenninger 1974 Rasa 1976 H and Roper 1978] Nonetheless reexamination of the experimental observati to date is warranted by 1) Some recent significant contributions to the liter 2) the potential importance of this not yet widely appreciated phenomenon particularly with regard to the temporal patterning of ag_ressive behavior an the possibility of relating this work to some observations on human aggressio

### Temporal Patterns of Aggressive Behavior

The experimental analysis of the reinforcing properties of a ression is com plicated by the variety of temporal patterns occurring in a_gressive behavior 1 patterns have both methodological and theoretical implications and must ther fore be reviewed here briefly There are at least 3 of these temporal effects th are of concern

**Warm up and priming effects** In the presence of a continuously available target birds [eg Hinde 1954 Curio 1975] and fish [eg Peeke et al 1971] show initial transient increases in the rate of mobbing or rate of intraspecific attack respectively These warm up periods often last from 1–3 minutes but may continue for 30 minutes or more particularly in fish [eg Peeke et al 197 I am unaware of similar data for mammals However a possibly related obs tion in mice is the priming effect [Hogan and Roper 1978] A brief a encounter transiently facilitates operant performance for the opportunity to perform additional aggressive behavior [eg Lagerspetz 1964 Tell en an Hor

97) These effects may be comparable to anecdotal accounts of human beings whose a essive behavior escalates itself into a violent frenzy [eg Baenninger 1974 Zimbardo 1969]

**Bout effects** In the presence of a continuously available tar_et aggression like many other behaviors tends to occur in bouts A closely spaced group of individual attacks is often followed by periods of littl or no aggressive activity In rats th se refractory p riods vary from a 2–3 minute pause following a single bitin attack [Adams 1976] to a 10 minute pause after a 5–6 minute bout of attack [Blanchard and Blanchard 1977] For hamsters the mean bout duration is approximately 2 mirutes while the mean interbout interval is approxi ly 15 minutes [Potegal et al 1976] Hogan et al [1970] report that fi_hting a onisti displays occurring at a mean of 15/hour tend to cluster in groups of 8 implyin_ that th mean interbout interval is approximately 20 minutes

**Satiation effects** Some studies have indicated that if an animal is allowed to k a tar et ad libitum for an extended length of time the rate of attack de res r latively rapidly Thus in mice a_gression decay times [time for attack to reach 37% (1/e) of its initial value] of approximately 30 minutes can be lculat d from data of Levine et al (1965] and of Thurmond [1975] If after an erval animals are again allowed access to a target the amount of a ression in ses with in reasing intervals Estimates of the minimum interval necessary for overy from a ression satiation in mice which must obviously be dependent the de ree of satiation range from 2 days [Scott and Frederickson 1951] to eeks [Krsiak and Janku 1969] Connor summarizes the most systematic dy of this question in remarkin_ that in his experiments 1) the satiation effect res d the aggression scores of mice to an asymptotic floor in four hours ss and 2) the deprivation effect elevated scores to an asymptotic ceiling in hours or less (Connor 1974 p 225) Amon_ various species of fish aggression ay times of 11 –28 minutes can be calculated from data of Peeke [1969] and eeke and Veno [1973] and times of 2–5 minutes from data of Heiligenberg [for w see Heiligenberg 1974] Recovery times vary from l ss than 1 day [Fiefer 7] to more than 5 days [Van den Assem and Van der Molen 1969 Peeke and ke 1972 Peeke et al 1971] It thus appears that in a number of different ies a ressive behavior is relatively quick to satiate and slow to recover imilar bout periods and satiation effects have been cl arly established in al behavior [eg McGill 1969 Karen and Barfield 1975] The relationship hese temporal effects in aggression t each other or to those in sexual vior remains un lear The methodological significance of these three p ral effects in aggression foll ws fr m this possibility The mechanisms h determine the timing of aggression in experimentally uncontrolled aggressive unters may influence or override experimentally imposed [eg operant] con Their theoretical signicance lies in the possibility that they may be under d eventually not as impediments to the experimental analysis of a ressive

motivation but as manifestations of fluctuations in aggressive motivation This possibility is discussed in greater detail in the last section of this paper

## Reinforcing Value of Predatory Aggression

Field studies of feral predators have revealed the existence of "surplus killin by foxes and other mammalian carnivores [Errington 1967 Kruuk 197?] In these instances the predators kill far more prey than they can eat at one time after which they leave the scene without attempting to cache the excess dead p In other instances predators [eg lynx] will kill but rarely if ever eat predator belonging to sympatric species [eg foxes] Kruuk offers a number of interpre tations of the adaptive significance of surplus killing The adaptive advanta e fo a predator of reducing the number of competitors seems obvious the advanta of destroying large numbers of prey is less obvious *It is possible that surplus ki ing reflects the practice of an enjoyable predatory skill which becomes mal-*adaptive under the ecologically unusual circumstance of abundant easily acces-ible prey Even if surplus killing could be shown to have some adaptive value it would still not obviate the necessity of determining the proximal behavioral means eg the motivational mechanisms by which the distal evolutionary ends are served

In the laboratory cats [Roberts and Keiss 1964] and rats [Myer and White 1965] will learn T mazes for the opportunity to make predatory attacks on ra s and mice respectively Rats will also bar press [van Hemel and Myer 1970 van Hemel 1972] for the opportunity to kill mice It is important to note that the subjects in these experiments had never eaten prey objects prior to the study a were not allowed to do so during the experiments Indeed several lines of evi-dence indicate that in many species predatory hunting and killing belong to a motivational system separate from that of feeding In the course of develo ment the two systems ordinarily become associated through learning [for a brief revie see Adamec 1976] Field observations suggest and laboratory studies confirm that predatory killing can be positively reinforcing whether or not the prey is ea

## Reinforcing Value of Intraspecific Aggression

There are anecdotal accounts of domesticated cats [Ewer 1968 p 156 Le h 1971] *meerkats [Ewer 1968 p 340] and buntings* [Andrew 1957] wh h appeared to go looking for a fight with conspecifics In the laboratory t e ward value of intraspecific aggression is suggested by the numerous demo stra-tions that winning or losing paired encounters can increase or decrease r spectiv subsequent attack rates in fish [Heiligenberg 1964 McDonald et al 1968] m [Uhrich 1940 Ginsburg and Allee 1942 Kahn 1951 Scott and Marston 19 Lagerspetz 1964 Brain and Poole 1974] or rats [Seward 1946] The re t e in attack initiation occurring after defeat is probably a straightforward avoida e effect due to punishment [cf Hudgens and MacNeil 1970] Increases in att k rates following victory are more problematic In these experiments ther was

nothin contingent on winning Therefore the increases in attack rate in victorious animals sug est that successful attack may be intrinsically rewarding

An al ernative to the positive reinforcement explanation of these paired en counter results has been proposed by Leshner and Nock [1976] They found that only mice whose aggressive encounters were interrupted before they had achieved victory (submission of their opponents) showed increased aggression Since mice which were allowed to fight to victory showed no change in aggressiveness they in rpreted the increases in aggression in terms of unfulfilled expectancy of victory on the part of the interrupted mice Theirs is an interesting hypothesis although it is unclear that an expectancy which remains unconfirmed should be necessarily result in a more rather than a less vigorous pursuit of that expectancy Al ernative explanations of these data exist For example it is possible that the non nt rrupted group which had considerably longer fight durations (up to an hour) may have satiated on fighting In any event Leshner and Nock have raised the important consideration that the reward value of aggression may involve not only the performance of and perhaps immediate sensory feedback from the motor acts of aggression but also the capitulation of the opponent

It can also be argued that subjects in the paired encounters learned to avoid pain inflicted by their opponents by attacking them first To demonstrate more clearly the appetitive nature of aggression it is necessary to show that organisms will learn and perform operant behaviors to provide themselves with intraspecific attack opportunities when they could easily avoid such interactions by not performing the operant Fighting fish (Betta splendens) and other fish species will learn to produce operant responses for the opportunity to display aggressively to live or model conspecifics or to mirrors [Thompson and Sturm 1965 Hogan 1967 Hogan et al 1970 Rnic 1977] These results appear to be somewhat ambiguous however Some authors report that the operant performance is highly correlated with aggressive display [Thompson 1963 Melvin and Anson 1969 Davis et al 1974 Rhoad et al 1975 Bols 1977] while others find that operant responding may continue after the display has habituated [Baenninger 1970 Baenninger and Mattleman 1973 Johnson and Johnson 1973 Turnbough and Lloyd 1973] *In these latter studies,* some other aspects of the visual presentation presumably also provided some reinforcing stimulation A second confounding factor in those studies of fighting fish which used a response independent mirror image presentation is that such a fixed mirror image *is less reinforcing* than a response contingent mirror image [Baenninger and Mattleman 1973] Mirror images are more aversive than live antagonists [Bols 1977] since the mirror images do not support the coordinated display interaction that occurs between two live antogonists [Simpson 1968]

Stronger evidence of aggression-contin ent operant performance can be found in studies involving actual attack rather than display When appropriate experimental precautions are taken to insure the relatively painless victory of the aggressor the demonstration of attack preference becomes possible For the

opportunity to perform aggressive behavior against conspecifics birds will peck keys [Thompson 1964 Cole and Parker 1971 Cherek et al 1973] fish will swim through apertures [Rasa 1971] and mice will bar press [Connor 1974 Connor and Watson 1977] or run in T mazes [Tellegen et al 1969 Legrand 1970 Tellegen and Horn 1972 Kelsey and Cassidy 1976] and obstruction boxes [Lagerspetz 1964] Rats [Dreyer and Church 1970 Taylor 1975] and hamsters [Eibl Eibsfeldt 1971] will run T mazes for attack opportunities Monkeys will pull a chain to provide themselves with an inanimate target [Azrin et al 1965]

Kelsey and Cassidy [1976] found that mice given a choice in a T maze showed no preference between an accessible target mouse and a mouse behind a wire screen They argue that the apparent preference for fi ht interactions observed in their own and other previous studies was unrelated to fighting but actually reflected the rewarding social value of the visual auditory and olfactory cues of the target mice Taylor [1977] interprets his observation that highly aggressive rats will choose to interact with another highly aggressive rat in preference to a submissive rat 30% of the time as support for the hypothesis that there can be an affiliative component in agonistic interactions While this is an important theoretical and methodological point the conclusion that social affiliation is necessarily the sole reinforcement present in the fighting situation is not justified by the results Since Lagerspetz [1964] has suggested that priming is necessary for reinforcement by aggression in mice it is noteworthy that the ICR mice used by Kelsey and Cassidy unlike the several strains tested by Tellegen and Horn [1972] did not show any priming effects on successive trials Furthermore Kelsey and Cassidy s target mice were not optimal because they could counter attack Therefore the fighting encounters may have been less than completely rewarding for the aggressive mice One lesson to be drawn from this work may be that the strong affiliative tendencies of colonial species like the rat make them an inappropriate choice for studies of relatively pure aggression reinforcement Conversely species which are territorial isolates in the field eg the hamster may be more appropriate choices Although some questions remain the weight of evidence supports the conclusion from the earlier paired encounter studies that under appropriate conditions the performance of intraspecific aggression is positively reinforcing

## Further Comments on the Reinforcing Value of Intraspecific Aggression

Since the animals in these operant conditioning experiments were actively seeking out targets it is clear that they were not fighting in order to remove the presence or interference of another [Craig 1928] Though in the field such fighting might result in the dispersion of animals which is a presumed adaptive function of intraspecific aggression [Wynn Edwards 1962] this is not a causal

proximal factor in the behavior of individual organisms In the theoretical views of G kman and Schiff [1968] intraspecific and predatory aggression are pe form d because th ir performance has come to be rewarding to the individual through evol tion just as many other species typical acts have so evolved Since attack is a prepotent response under the circumstances of these experiments the result s might also have been predicted from Premack s [1959] principle that the opportunity to perform a behavior which occurs at high rate can be used as a re for r for a b havior occurring at a lower rate

Th co nitio of the positively reinforcing character of intraspecific aggression has been delayed for obvious reasons anecdotal accounts of enthus astic fighters among humans notwithstanding In naturalistic encounters the possibility of co n attack from the target has made attackers fearful as well as aggressive a d the re nforcing effects of aggression have be n obscured by the simultaneous pr n e of fear Intraspecific attack may contain elements of or alternate with defense (see below) In the laboratory however it is possible to artificially a ange encounters so that the aggressor can be assured of a painless victory and the f ar components eliminated through learning This interpretation fits n cely with the effects Kahn [1951] obtained using Scott s technique for training f ting mice Elimination of fear by a succession of easy wins eradicated autonomi compon nts of fear (pilo erection defecation) and of the prefight threat display [threat is often taken as an indicator of ambivalent motivation eg Ewer 1968] and produced rapid repetitive severe and indiscriminate attacks by the trained mice

A few studies which have explored the characteristics of intraspecific aggres n as a reinforcer suggest that it may be weaker than and/or different from more conventional reinforcers Thus Hogan et al [1970] have found that fight ing fish fail to achieve high ratio performance on operant schedules when display eliciting vis al stimuli are used as reinforcers When compared directly to food re forcement under similar conditions visual reinforcement also produ es lower r tes of responding and faster extinction [Hogan et al 1970] Similar results have be n reported with fighting fish by Thompson [1969] and Turnbough and Lloyd [1973] and with fighting cocks by Thompson [1964] although in these latter studi s it is unclear whether aggressive displays were actually being elicited Both Hogan et al [1967] and Thompson [1964] remarked that operant responding for aggress on often came in bouts in contrast to the more regular respond ng found for food reward Thus may reflect the natural bout structure grouping of atta ks and may account for the failure to acquire high ratio schedule performance

Hogan [1974] and Fantino et al [1972] provided food-deprived fi hting fish s simultaneous choices between food and mirror display reward Hogan found overall preference for food Fantino et al reported a preference for display The d ffe ences in results cannot be explained in terms of relative food deprivation

since Fantino et al s subjects were deprived for longer periods than Hogan s Another procedural difference may be important however Fantino et al per mitted continuous unrestrained access to both rewards Hogan followed two fr choices by two forced choices of the other reward If maximum aggressive be havior is dependent on a warm up effect produced by successive displays [Hoga and Roper 1978] then Hogan s procedure would not have yielded maximum aggression because of the interruptions occurring between successive displays T same may have been true in the Rnic s [1977] study For further reivew of the relevant studies of aggression in fish see Hogan and Roper [1978]

Among mice Tellegen and Horn [1972] found acquisition of T maze perforn ance for aggression reward slower than that for food reward Connor and Watsor [1977] report that the opportunity for intraspecific attack supported the acquisition of an operant 2 bar discrimination but not its reversal

These differences between aggression and more conventional reinforcers may reflect the imposition of the temporal properties of aggression on the operant situation The existence of warm up and satiation effects implies that operant performance may be affected by the subject s immediate prior history of fightin Evidence for this supposition comes from studies in which a brief priming fight occurring immediately before a trial in a shuttle box [Lagerspetz 1964 Legra d 1970] or a T maze [Tellegen et al 1969 Tellegen and Horn 1972] significantly facilitates operant performance for aggression This priming effect may reflect general arousal it may also indicate that the performance of an aggressive re sponse makes the performance of subsequent aggression more reinforcing This in turn is only one aspect of the difficulty in monitoring and manipulating lev ls of aggressive motivation Thus adequate comparisons between the reward value of conventional reinforcers and the opportunity for intraspecific aggression is d pendent upon finding solutions to the problem of the experimental control of aggressive motivation

**Reinforcing Value of Defensive (Irritable) Aggression**

Aversive stimulation (eg foot shock) is a well known and widely used experi mental provoker of attack Two of the operant studies cited above [Dreyer a d Church 1970 Azrin et al 1965] used shock to provoke attack suggesting that even with painful stimulation attack can be positively reinforcing However pa n induced aggression obviously occurs in a generally aversive situation The atta ks elicited in this situation may more closely resemble naturally occurring d fensive aggression rather than appetitive intraspecific aggression This implies that th animal would flee rather than attack if given a choice For exampl the upright posture shown by rats in the shock situation was called the fighting postu e by Ulrich and Azrin [1962] However this posture can be identified with the up right defense posture assumed by wild rats [Barnett 1958 Eibl Eibsfeldt 1958 and by laboratory rats [Grant and Mackintosh 1963] when attacked by a co

cific Recent experimental evidence has strengthened this identification for s [Reynierse 1971 Blanchard et al 1978] although the data for mice a e what more ambiguous [Kimbrell 1969 Legrand and Fielder 1973] If as is ally assumed defensive postures indicate fear and/or a preference for flight e observations lead to the expectation that in rats at least avoidance and cape would be preferred to atta k in the shock elicited fighting situation Studies of the relationship between attack and escape in shock-eli ited de n aggression do not at first glance fulfill this expectation Shock-elicited k between paired rats occurs with sufficient frequency to retard their acquisi [Azrin et al 1967 Flory and French 1971] and/or performance [Ulrich and ine 1964 Ulrich et al 1967 Ulrich 1967 Davis 1969 Logan and Boice 69] of operant (bar pressing) escape or avoidance of shock The int raction ween operant escape and attack depends on experimental conditions [Azrin l 1967] and the subjects prior experience [Powell et al 1972] However in et al [1967] found that with repeated sessions operant escape eventually me prepotent More g nerally our earlier expectations are fulfilled if escape oidance response topography are considered Attack competes with escape when bar pressing is the operant for producing escape ie delay of shock actual physical escape ie flight from the shock chamber is possible e becomes totally prepotent over attack [Azrin et al 1967 Logan and Boice Wolfe et al 1971 Whitman and Doleys 1973] Similarly when shock can oided by freezing in a certain orientation no fighting occurs [Sbordone 1977] Thu when attack and escape (or avoidance) are compared using "primitive unlearned responses escape (or avoidance) is prepotent in hock situation Attack which has been elicited by aversive stimulation may mewhat reinforcing perhaps as a way of coping with stress [Weiss et al ] but the preferred response is escape from the entire situation This result perhaps serve as a metaphor if not a model of some human aggression eg rs conscripted into combat

## orcing Value of Intracranially Elicited Aggression

tudies of brain stimulation suggest that the reinforcing properties of different iors may be an integral part of the neural circuitry which produces the iors Since aversive peripheral stimulation can elicit attack it is not surpris t Plotnick et al [1971] found that aversive central stimulation in monkeys o elicit attack It is important to note however that by no means all the s tes stimulation of which was aversive yielded attack when stimulated 1961] reported that hostility provoking amygdala stimulation was exp as unpleasant by a human patient re is also evidence that brain stimulation-elicited attack can be positively cing Nakao [1958] and Fonberg [1967] found that cats and dogs would the opportunity escape from hypothalamic stimulation whi h produced

fear flight reactions but would *not escape from* rage attack producing stimulation [but see Roberts 1958] In partial agreement Adams and Flynn [1966] reported that cats would escape from medial hypothalamic stimulation which elicits affective defense but not from lateral hypothalamic predatory attack stimulation Stimulation of the hypothalamus in the rat has produced the same medial vs lateral differentiation found in the cat Vernges and Karli [1970] found that medial hypothalamic stimulation elicits an affective defensive poorly directed apparent negatively reinforcing attack Effects of lateral hypothalamic stimulation are mixed but as suggested by Woodworth [1971] may be described as follows In a posterior region lateral and dorsal to the ventromedial nucleus of the hypothalamus (VMH) stimulation produces a well organized and natural appearing apparently positively reinforcing predatory killing attack [De Sisto and Huston 1971 Woodworth 1971 Panksepp 1971 Vernges and Karli 1969] Stimulation in a more anterior region ventrolateral to the VMH is more likely to produce an affective apparently negatively reinforcing attack similar to the effects of medial stimulation [Panksepp and Trowill 1969 King and Hoebel 1968 Panksepp 1971]

Other evidence for positive reward value comes from tests of self stimulation at attack producing sites in the brains of monkeys rats and guinea pigs Robinson et al [1969] De Sisto and Huston [1971] Woodworth [1971] Chaurand et al [1974] and Martin [1976] have reported that brain loci yielding intraspecific or predatory attack upon stimulation will also support self stimulation Unfortunately the interpretation of these observations is problematic Valenstein [1974] has made the entirely justified criticism that the typical operant tests of self stimulation involved quite different temporal and *subject control parameters* of stimulation than those used to elicit aggressive behaviors The fact that self stimulation effects are wholly dependent on parameters like pulse duration [Valenstein and Valenstein 1964] and subject control [Steiner et al 1969] suggests that the definitive tests in which the same stimulation parameters are used both for eliciting aggression and for self stimulation remain to be performed

## Some Speculations on the Reinforcing Value of Aggression Among Humans

If human hunting with weapons is regarded as homologous or analogous to predatory behavior then the existence of sports hunting would suggest a similarity in the reinforcing values of these behaviors However differences in weapons, traditions and social circumstances of hunting in different cultures make it difficult to ascribe the reinforcing value to the killing itself In general the absence of species typical stereotyped behaviors among humans makes it difficult to categorize various instances of human aggression A possible exception to this statement may be the existence of pancultural facial expressions of anger (among other emotions) described by Eibl Eibsfeldt [1971] and Ekman [1973] Perhaps anger may be regarded as the subjectively experienced affect accompanying some f[illegible]

of intraspecific a gression in humans Here we must largely rely on subjects ' bal reports of pl asure and displeasure the correspondence of such verbal re ports to the beh avioral indicators of reinforcement is as always moot

Tho h an er is regarded as a negative emotion by many psychologists there r r curring reports that at least some individuals show or report pleasure in r ssion of a r and/or overt attack There have been such comments from or h ut children [Bovet 1923 Bender et al 1936 Goodenough 1931] farm boys [Eibl Eibsfeldt 1974] graduate students [Richardson 1918] athletes [Mel es and Harris 1970] psychiatric patients [Hartmenn et al 1949 Freud 1972] wer n soldiers [Gray 1967 Storr 1972 Zimbardo 1969] and nonwestern warriors [Watson 1971] The persistence of gratuitous cruelty and torture through out human h story has sometimes been explained by its reinforcing value [Storr 1972] Such pleasurable feeling may not however be simply a concomitant of specifically aggressive overt attack Pleasure may derive from the vigorous phys ical activity of fi hting the accompanying arousal or the successful performance of a complex fi hting skill Pleasure may also issue from the fruits of victory lateral rewards and social approval of machismo and/or of skill in fighting tra ndividual processes of self image enhancement and/or of the strengthen ng psychodynamic defenses may be equally or more important For some people muli associated with aggression may become secondary rewards by being con ioned to more primary rewards certain personality types and past histories p dictive of increased attack when pain cues are elicited from the victim r evi w see Berkowitz 1974 see also Toch 1969 p 162 Zimbardo 1969 eler and Caggula 1966 Swart and Berkowitz 1976] Some of these processes y be reflected in the interest of some individuals in violent spectator sports m ancient gladiatorial contests to contemporary demclition derbys In other viduals aggression induced feelings of pleasure may be masked by guilt and sion anxiety

ome combination of these and other processes may account for the extreme static violence described in anthropological and historical sources eg the tle joy of the Viking berserkers of Andaman islanders and of Malaysian can and American Indian groups in which fear app arently vanished and the ior was seized with a feeling akin to joy [Kennedy 1971 Storr 1972 ardo 1969 Dentan 1968] Extended rituals involvin vigorous dancing ting and strong social approval if not ontagion of a gression [eg Wheeler Caggula 1966] appear to be a ne essary preparation or accompaniment in of these cases Repetitive protracted violent attack has been reported to to similar ecstatic states in contemp rary accounts of military violence in iam [Zimbardo 1969] and of civilian violence in Columbia [Leon 1969] ch reports are reminiscent of the well known phenomenon of amok occurring g certain ethni groups in Malay sia Indonesia and the Philippines [Schmidt 1977 Burton Bradley 1968] In fact the histori al allusions to amok suggest

that a century or more ago *amok* may have been similar to the instances described above a state of high aggressive motivation induced through social contagion as a preliminary to pirate raids [Galloway 1923] or to warfare [Murphy 1973] In the course of time the nature of *amok* has evidently chan ed The current consensus appears to be that contemporary *amok* is a 4 part syndrome afflicting individuals in whom an acute or chronic social stress produces a period of withdrawal followed sooner or later by a relentlessly homicidal outburst Survivors of their own *amok* episodes claim amnesia for the event Phenomena resembling *amok* in some of these respects although with a lower probability of homicide have been reported among the natives of Tierra del Fuego [Coriat 1915] Kenya [Carothers 1948] and of New Guinea [Langness 1965 Lowman Vayda 1971]

There seems to be some resemblance between the current form of *amok* and ecstatic violence including a narrowing of the perceptual field and a disregard for personal safety [Schmidt et al 1977] during attack On the other hand Van Loon s [1927] old account presumably based on interviews with *amok* survivors suggests that *amok* is a subjectively terrifying rather than euphoric experience This is consistent with reports of paranoid ideation in *amok* survivors [Schmidt et al 1977] While historically *amok* may have been related to the deliberately induced aggressive motivation of ecstatic violence currently *amok* appears to be a culturally sanctioned response to stressful social situations

Some psychiatrists have suggested that ecstatic violence may be similar or equivalent to sexual pleasure and orgasm [Novick and Novick 1972 Miller and Looney 1974 Fornari 1975] Although it has been found that strongly but not weakly erotic stimuli can nonspecifically facilitate aggression [Donnerstein et al 1975 Zillman and Sapolsky 1977] the biological origins of ecstatic violence should probably be sought in the reinforcing value of aggression not sex In special circumstances in which social prohibitions and internal inhibitions (eg aggression anxiety) are weakened a response which is intrinsically reinforcing and which facilitates its own motivation must produce a positive feedback of the kind observed in ecstatic violence Ecstatic violence may be the human equivalent of the warm up and priming effects seen in other animals According to this hypothesis cultural sanctions determine the circumstances of the attack the weapons selected and the victims initially chosen Once the attack is set in motion intrinsic biological mechanisms become more important in determining the ultimate outcome [Zimbardo 1969]

The form of extreme overtly homicidal aggression experienced personally by the largest number of people is war Most soldiers are conscripted under such conditions of low aggressive motivation and realistic evaluation of danger f ar is the most commonly reported emotion in battle As in the laboratory experim a s

with nonhuman animals described above special circumstances must occur to unmask the positive reward value if any of aggression Certainly easy killing [ ba 'e] does seem to generate in human beings symptoms of pleasure [Keeton 1976 p 278] The development of high aggressive motivation which or 'omes f ar can apparently have a similar effect The weight of the evidence sug sts that overtly homicidal aggression becomes strongly positively reinforcing f the majority of humans only under special conditions of high aggressive moti va' on and low inhibition

## Implications for Theories of Aggressive Behavior

This paper began with a description of some of the temporal patterns involved in a gression The succeeding sections reviewed the evidence for the positively re forcing value of predatory and intraspecific aggression under the appropriate c ditions In this last section I present the hypothesis that these two sets of bservations are related Other things being equal temporal fluctuations in attack ate are a consequence of fluctuations in the reinforcing value of aggression arm up and priming effects reflect an initial transient increase in the reinforcing alue of ag ession refractory periods and satiation effects reflect a longer term ecrease This hypothesis is generally in keeping with contemporary notions of centive motivation according to which reinforcers pull responses more than ives push them (eg Bindra 1974] The specific model for this hypothesis the work of Cabanac [1971] who in a series of elegant experiments has shown at the hedonic value of a stimulus (eg a pulse of heat or a taste of sugar) is pendent upon the state of the subject (skin temperature or sugar load)

In the context of aggressive behavior the term aggressive states (AS) seems propriate The aggressive states are those sets of internal conditions which ern among other things the reinforcing value of an overt attack In conjunc n with a variety of other internal and external conditions (eg stimulus situa learning history) they determine moment to moment attack probability The jective experience of anger in humans may reflect a conscious concomitant of Hopefully AS can eventually be linked to definable sets of neural and monal mechanisms

The fact that both warm up and satiation effects are induced by prior aggres acts implies that there must be multiple feedback connections between AS overt aggression Thus the occurrence of warm up effects implies the tence of a positive feedback link between overt attack and AS Conversely rate short term and long term negative feedback relationships between overt ck and AS can account for refractory period and satiation effects respectively etailed discussion of these feedback mechanisms is beyond the scope of this

paper The important point for the present is that when environmental variables are adequately controlled temporal fluctuations in aggressive behavior may be viewed as manifestations of changes in the underlying AS

On this hypothesis it is obvious that changes in AS indicated by temporal fluctuations of overt aggression must necessarily have a profound effect in the operant experiments described above More generally although the positive re inforcing value of aggression particularly in humans may become substantial only under special conditions this phenomenon must be reckoned with in any general theory of aggressive behavior

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AGGRESSIVE BEHAVIOR
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# Modulation of Aggression Toward an Intruder During the Reproductive Cycle of White King Pigeons (Columba livia)

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For three of four mated male pigeons intrusion of a still two-dimensional image of a conspecific into the reproductive situation initiated aggressive behavior over months of daily testing with little habituation There was a transient increase in aggressive contacts against the head of the target within two days prior to or following the occurrence of the second egg Such an increase did not occur with extended daily testing of the male alone and was more closely synchronized to egg laying than time since the introduction of the female The results are consistent with previous studies of reproductive and schedule induced aggression in birds

Key words aggression reproduction pigeon conspecific target incubation intruder incubatory disruption

## INTRODUCTION

Cohen et al [1979] reported that the head of a conspecific target selectively controls aggression induced by an intermittent food schedule in pigeons On the basis of their findings and similar results from studies of reproductive aggression toward an intruder they proposed that schedule induced and reproductive aggression in pigeons may be closely related Specifically they suggested that for pigeons and possibly other birds there may be a common perceptual basis for visually identifying an opponent in aggression inducing situations The aggressive

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pigeon may only attend to a specific visual feature(s) of its opponent To assess the generality of the selective target control of schedule induced attack in pigeons and other possible similarities between schedule induced and reproductive aggression in that species it is first necessary to establish that the conspecific target image used in prior schedule studies [eg Cohen et al 1979 Looney et al 1976] will initiate aggression when intruded into the pigeon s reproductive cycle and that the aggressive behavior toward it is systematically related to the phase of reproduction

Studies of avian reproductive aggression toward an intruder have provided measures of aggressive behavior toward some animate and inanimate targets but not on a daily basis throughout the cycle In Smith and Hosking s [1955] studies of passerines for example a pictorial image of an intruder was not attacked at all during the reproductive cycle Similarly Vowles and Harwood [1966] studying ring doves and more recently Spurr [1974] studying Adelie penguins encountered difficulties in obtaining daily measures of reproductive aggression toward animate and inanimate targets The experiments summarized below examine daily fluctuations in the White King pigeon s aggressive behavior against an intruded conspecific target image that previously was shown to be effective in initiating schedule induced aggression

## GENERAL METHOD

### Subjects

The subjects were four mated pairs of White King pigeons (P345 P346 P347 P348) that had at least one prior breeding experience at Palmetto Pigeon Plant (Sumter SC) before arrival in the laboratory In the laboratory colony room they were housed in individual 39 X 52 X 30 cm cages maintained under controlled lighting conditions (lights on 0700–2100 hr) and given free access to food grit and water

### Apparatus

Two breeding chambers were located in a room separate from the colony room Each chamber was a modified steel dog cage (73 7 X 106 7 X 66 0 cm) with the front (73 7 X 66 0 cm) replaced by wire mesh to allow video monitoring by a QSI (Model Q5000) low light video camera As shown in Figure 1 a nest bowl (13 cm in diameter) was located in one corner formed by the mesh screen and side wall On the side wall 20 cm from that corner (center of screen to corner) was a 11 5 X 15 3 cm rear projection screen [Cohen et al 1976] suspended by [illegible] switches so that screen contacts could be recorded The bottom of the screen was 7 cm above the floor and a projector [Cohen et al 1976] was mounted behind the screen Centered on the side wall opposite the screen were dispensers for nest material (pine needles) food grit and water A 15 watt daylight fluorescent bulb mounted on the ceiling of the chamber provided the same lighting conditions

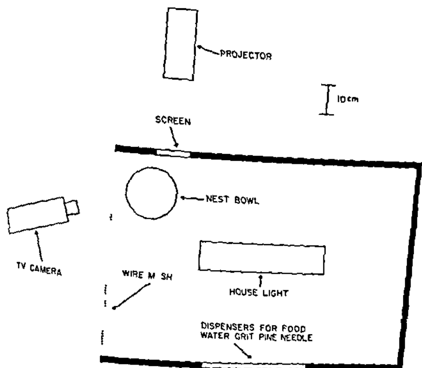



Fig 1 Overhead vi w of breeding chamber

us d in the colony room A fan provided ventilation and masking noise The target stimulus was a rear projected full view colored image of a male White King pigeon (intact target) [Cohen et al 1979] that was unfamiliar to the experimental birds and is effective in releasing schedule indu ed aggression Solid s ate equipment and counters were used to schedule experimental conditions and record target contacts from an adjacent room

### Preliminary Breeding Procedure

After a minimum of four weeks in visual isolation each pair was placed in the breeding chamber with free access to food water g it and nest material They rema ned there for seven to ten days after the occurrence of the second of two s for a total of 12 17 days Each pair was given this preliminary breeding perience either one or two times separated by a minimum of two weeks in lation The male was marked with a black dot on the tail for easy visual identifi on During breeding the temporal sequence of pre incubatory behavior (cour

ship copulation nest building and demonstration and laying of two eggs spaced 24–36 hours apart) and incubatory behavior of the White King pigeons [Levi 1974] was comparable to that of other pigeons and doves as described by Fabricius and Jansson [1963] Lovari and Hutchinson [1975] and Miller and Miller [1958]

### Target Intrusion Procedure

During testing alternation of breeding in the test chamber with two weeks of visual isolation in the colony room continued with the addition of daily intrusions of the conspecific image into the breeding chamber Although several different methods of intruding the target during a daily test session were used (as described below) the general testing procedure was as follows A pair of birds was placed in the chamber at approximately 1600 hr and daily testing was begun the next morning During testing the fluorescent chamber light was turned off for the duration of the target presentation (5 or 15 min/day) to ensure a clear image and to obtain stimulus conditions similar to those used in schedule induced aggression studies [Looney et al 1976 Cohen et al 1979] During most test sessions the pigeons behavior in the area of the nest bowl and screen was video monitored Video recordings were made periodically Test sessions were conducted at 0900 hr seven days/week except when precluded by equipment difficulties During breeding birds remained in the chamber until after hatching of the squab or abandonment of the eggs In Experiments 1 2 and 3 if the birds did not incubate the eggs for two consecutive days or if one or both eggs were broken testing was terminated and birds returned to the colony room for at least two weeks

Pilot experiments with ad libitum food indicated that the male of the mated pair initially exhibited aggressive behavior (pecking charging bow-coo) toward the conspecific image However attack habituated after several target presentations within one test session In addition both the male and female manipulated food spilling and distributing it around the chamber ( false feeding ) [Murton et al 1969] These observations together with prior reports [Azrin et al 1966 Dove 1976] that restricted food intake facilitates aggressive behavior suggested that free access to food was not a suitable condition for obtaining sustained reproductive aggressive behavior against a two dimensional conspecific image Consequently in all of the following experiments access to food was reduced from ad libitum to one hour/day (1200–1300) such that the birds were deprived of food for 20 hours at the time of testing (0900 hr) Birds were maintained on the same restricted food schedule during isolation

## EXPERIMENT 1

During the initial experiment two pairs of birds were given repeated exposures to the conspecific image during each day of the reproductive cycle

346 and 347 were used Each daily session consisted of ten 90 second ations of the target for a total presentation time of 15 minutes/day Five s elapsed between target presentations The number and temporal distribu contacts on the projection screen with and without the target turned on corded for each one hour session

and Discussion

video monitoring and periodic video tape recording of test sessions ed that only the males of the mated pairs exhibited aggressive contact and pecking at the head) and noncontact (guttural vocalization bow havior toward the intruded conspecific image Virtually no behavior occurred the screen when the target image was turned off When the target image was d the female left the vicinity of the target and nest regardless of whether incubating the eggs

re 2 summarizes daily fluctuations in aggressive contact (contact/min on on the intruded conspecific image during the reproductive cycle as a func successive breeding days with arrows indicating the occurrence of the eggs tening of the squab P346 and P347 incubated eggs during initial breeding absence of the target However the initial two attempts to breed P347 with get intruded resulted in their abandoning and breaking their eggs within two f laying Available data from those initial cycles for P347 were consistent at of the third more successful attempt in which the pair incubated their r 11 days following laying of the second egg The results for the third breed empt with the target intruded are presented in Figure 2 the males of both pairs there was a three to fourfold increase in attack rate to preincubatory levels within two days prior to or following the occurrence second egg and a subsequent decrease in rate of attack to approximately incubatory levels within two days prior to or following the occurrence cond egg without a further change in level of aggressive behavior whereas 46 hatching on the eighteenth day following the second egg was accom l by a second increase in attack rate Although the breeding cycle for 347 srupted males of both pairs showed a transient increase in aggressive contacts d the intruded conspecific image at the time of egg laying

## RIMENT 2

deo monitoring of incubatory behavior in Experiment 1 indicated that the eggs temporarily abandoned for the duration of the target presentations The male ed and pecked at the conspecific image and the female left the immediate ity of the nest Stout and Brass (1969) reported a similar disruption of incuba by the intrusion of a conspecific model into the nesting area of gulls In an

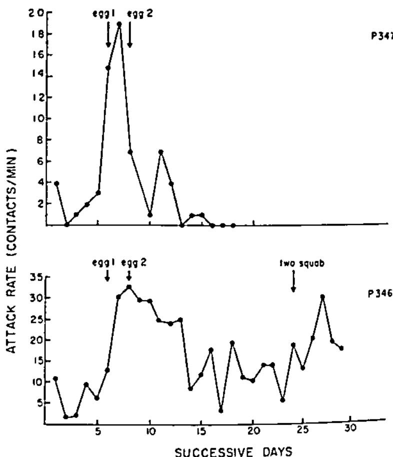



Fig 2 Attack rate (contacts/min) on the projected image as a function of successi e breed g days Day 1 corresponds to the first complete day of testing Note that the ordinate scales f r the upper and lower panels are different The arrows indicate the occurrence of the fi st and second eggs and in the case of P346 of hatching of squab

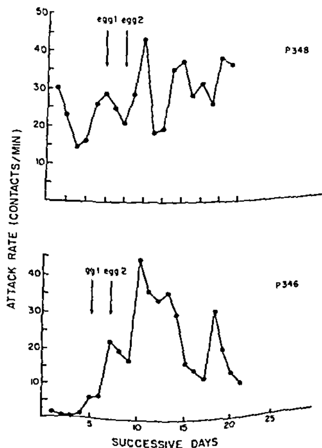
effort to reduce the disruption of incubatory behavior and prolong the reprodu tive cycle the duration and number of target presentations was reduced in the nex experiment

## Method

Mated pairs 345 346 and 348 were used The procedure was the same as tha used in Experiment 1 except that there was one five minute target presentati n per session instead of ten 90-second target presentations Number of contacts on the projection screen was recorded for five minutes preceding during and for fi minutes following presentation of the conspecific image

## Results and Discussion

Figure 3 summarizes daily fluctuations in the male's aggressive behavior toward the intruded conspecific image for the portion of the reproductive cycle completed for P346 and P348. With the reduced exposure to the conspecific image in this experiment, P346 (that successfully bred in Experiment 1) and P348 abandoned their eggs midway through the incubatory period (days 19 and 21, respectively). Both pairs showed a transient increase in aggressive behavior at egg laying. The results for P345 are not included, since the male of that pair failed to exhibit sustained aggressive behavior toward the intruded image. Unlike the other two pairs, P345 completed the reproductive cycle through hatching of the squab in spite of the daily intrusions of the conspecific image.




Attack rate (contacts/min) on the projected image as function of successive days. Day 1 corresponds to the first complete day of testing. The arrows indicate laying of the first and second eggs.

As was the case in Experiment 1 an increase in attack rate occurred withi days prior to or following the occurrence of the second egg Whereas attack r subsequently decreased for P346 there was less of a decrement for P348 Re sentative event records of aggressive contacts on the screen before during ar following image presentation are presented in Figure 4 Both males initiated at target onset For P346 attacks occurred primarily during the initial two to three minutes whereas for P348 attacks continued until target termination occasionally running over into the target off condition

## EXPERIMENT 3

The sustained rates of attack and repeated temporal contiguity of attack a target termination (Fig 4) for the male of P348 suggested that target termina or onset of the chamber light may have adventitiously reinforced [Skinner 1' Azrin and Hutchinson 1967] target responses Since reinforcement of attack could mask daily changes in aggressive behavior related to the phase of the reproductive cycle the testing procedure in Experiment 3 was modified to en that target termination and light onset were not immediately preceded by a target contact In addition to assess daily fluctuations in aggressive behavior i nonreproductive situation the male was exposed to daily test sessions in the breeding chamber with and without his mate available

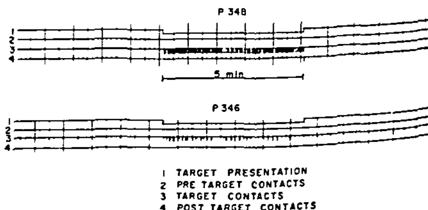



Fig 4 A representative event record of aggressive contacts on the screen bef re d n a following a single five minute presentation of the conspecific image for P346 and P348

Method

Followin Experiment 2 the females of pairs P346 and P348 eggs and used
stin materials were removed from the test chambers Each male remained in
he chamber alone and was exposed to the testing procedure for ten daily sessions
d by the reintroduction of the female with continued daily testing The
procedure was the same as that used in Experiment 2 except that a protective
ncy ensured that target termination and light onset were not immediately
led by a targ t contact If a target response occurred during the final ten sec
s of the scheduled five minute image presentation the image remained on and
he lights off un no contacts occurred for an additional ten seconds

pon completion or termination of the reproductive cycle the female eggs
nd used nestin material were again removed and the male alone was tested for
(P348) or 27 (P346) days The breeding (♂ ♀) condition was then
ed for both pairs Finally the males of P348 and P346 were left alone for
d four days respectively

sults and Discussion

Figure 5 summarizes daily fluctuations in the males aggressive behavior
ts/min) toward the intruded conspecific image for successive breeding
♀) and nonbreeding (♂) conditions As in Experiment 2 both pairs of birds
doned their eggs midway (5–7 days following the second egg) through the
tory period Introduction of the female initially suppressed atta k against
truded ima e for P346 and to a lesser degree for P348 With the exception
e day (57) for P346 attack rate was less than 20 contacts/min during the
ubatory periods for both birds and was followed by a twofold increase in
k rate within two days prior to or following the occurrence of the second egg
ubsequent decrease in attack rate during the incubation period for both
in this experiment suggests that adventitious reinforcement by target termina
r chamber light onset contributed to the sustained high rates of contact on
et following egg laying for P348 in Experiment 2 For both pairs removal
female had no systematic effect upon the males attack rate In addition
xtended daily testing (25–27 days) between breeding cycles the males
showed no evidence of transient increase in attack rate like that observed
time of egg laying during the breeding cycle although attack rates gradually
sed over successive days for P346 and decreased for P348

al Discussion

three of four male White King pigeons on a restricted food schedule in
of a nonmoving two-dimensional image of a conspecific into the reproduc
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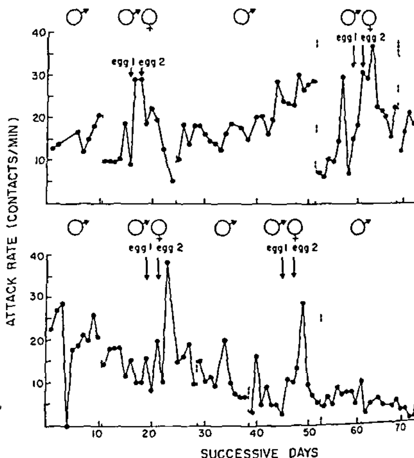



Fig 5 Attack rate (contacts/min) on the projected image as a function of su cess (♂ ♀) and nonbreeding (♂) days The arrows indicate the occurrence of the first and during breeding

effective in maintaining schedule induced aggression over months of daily in the same species Since only the one conspecific image was used in the ment it is unclear whether aggression toward it was selectively controlled conspecific target s head as it is with schedule induced aggression [Cohen 1979] Audiovisual monitoring however suggests that attack was control the head since aggressive pecks were directed at that region of the consp image Perhaps intermittent intrusion of other visual stimuli such as an a bird of a sympatric species a predator or even an inanimate stimulus be sufficient to initiate aggression Additional research is needed to prov detailed description of the aggressive motor patterns and vocalizat o s th toward the intruded stimuli as well as the specificity in visual targ t contr that behavior during the reproductive cycle

The present experiments demonstrate the feasibility of studying the daily ... of aggression toward an intruded stimulus in the reproductive context ... (general procedure) indicated that the sustained level of aggression against two-dimensional image in the present experiments was related to the restricted schedule. This is consistent with failures to obtain sustained aggression ... an intruder in prior studies in which food was not explicitly restricted ... and Hoskins 1955 Vowles and Harwood 1966] as well as Hinde s [1970] ... that changes in internal state can influence the relevance of the stimulus

... reported in studies of reproductive aggression in birds [Smith and ... 1955 Vowles and Harwood 1966 Spurr 1974] the male in these ... was more aggressive toward the intruder than the female and the ... of aggressiveness toward the intruded image varied considerably between birds ... of intersubject differences in rate of aggressive contact the three of four ... that exhibited sustained aggressive behavior against the intruded image ... a transient increase in rate of target contact within two days of the ... of the second egg The form and time course of that increase is similar ... results obtained with ring doves [Vowles and Harwood 1966] using a group ... In Vowles and Harwood s experiment maximum aggressive behavior ... four to six days following the occurrence of the first egg Spurr [1974] ... reported an increase in aggressiveness after egg laying in Adelie penguins ... in that study aggressive behavior did not reach a peak until the time of ... hatching The peak in aggressiveness in this study is closer to the time of egg ... than in the experiments with other species which may be related to the ... differences in species experimental conditions (daily testing targets etc) and ... (within vs between subject)

... Although the factors responsible for the transient increase in the male s ... aggressiveness toward an intruder following egg laying are unclear recent studies ... ring doves [Silver et al 1974 Feder et al 1977 Silver 1978] suggest that ... changes in the levels of progesterone testosterone and prolactin at the time of ... laying are not responsible for this increase Similarly the decrease in the male s ... aggressiveness toward the intruder following the introduction of the female (Experiment 3) shows that any major change in the male s external environment is ... not necessarily accompanied by enhanced attack on the intruded image The ... results of Experiment 3 indicate that the increase in aggressiveness at egg laying ... is not due to extended daily testing of the male alone and is closely synchronized ... with egg laying and not to the amount of time elapsed since the introduction of the ... female It is likely that the transient increase in the male s aggressiveness toward ... the intruded image at egg laying is related to the external stimulation (visual ... auditory olfactory) that accompanies the onset of incu

With the exception of the first breeding cycle for P346 (Experiment 1) all three pairs of birds that exhibited sustained aggression toward the intruded con specific image also abandoned or broke their eggs midway through the incubatio period Although the cause of this incubatory disruption is unknown we have evidence that it is not due to the restricted food schedule Subsequent breeding of all pairs without daily intrusion of the target was successful through hatching in spite of the restricted food schedule In addition the pair (P345) that failed to exhibit sustained aggressive behavior against the conspecific image (Experim ı 2) completed the breeding cycle through hatching An alternative explanation of the incubatory disruptions is that the agonistic behavior that accompanies re peated forced intrusion of a novel conspecific image into the breeding area is sufficient to disrupt or block incubation The fact that the birds that showed the disruptive effect left the nest and engaged in agonistic behavior during the target presentation is consistent with this view Although this interpretation is appeal n in view of similar disruptive effects reported in field studies with birds [Lack 19 Smith and Hosking 1955] additional experiments are needed to determine if disruption of incubation in the present situation was specific to intrusions of a visual image of a conspecific

## ACKNOWLEDGMENTS

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AGGRESSIVE BEHAVIOR
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# )tal Damage in Infant and Adult s: Effects on Activity, Emotionality, Muricide

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:al lesions produced signs of increased emotionality in the adult rat the al syndrome (hyperresponsiveness to handling in the open field decreased ng and ambulation activity increased defecation deficient habituation) more or less complete and more or less marked depending on the age hich the lesion was performed (7 days or 3 months) the extent of the lesion icted to the septum or extending to more ventrally located structures) he environmental conditions in which the animals were reared (in groups isolation) All septal lesions provoked a similar and significant increase probability of occurrence of mouse-killing behavior irrespective of age eration extent of lesion and kind of rearing en ironment In a 24-hour raphy starting at 11 30 a.m., the rats septalectomized at adult age were :tive than controls during the initial period while all septals were dly more active than controls during the night period Early septal s only transiently disrupted weight gain The results obtained point to ex interactions between the effects of early brain damage and environ l conditions.

:at septum ontogeny emotionality mouse killing behavior open field

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## INTRODUCTION

The rat s mouse killing behavior has been investigated by our group for r than 20 years since the original descriptive study dealing with this interspec aggression [Karli 1956] The general perspective of our investigations in evitably changed over the years In a first stage both lesion and stimulation periments were carried out in order to draw up an inventory of the brain mechanisms which were thought to rather specifically facilitate or inhibit th release of the killing response [Karli et al 1969] Later on more emphasis laid on the intimate relations which exist between emotional reactions and responses in the ontogenesis of behavior and in the behavior of the adult organism [Karli et al 1974] More recently the fact that a brain lesion may different effects depending on whether the rat has had experience with mic prior to the operation led us to stress the role played by experimental facto *to uncover the essential part taken by the amygdala in mediating their influe* upon behavioral ontogeny [Karli et al 1977] The study reported in the pre paper cumulatively reflects these closely related preoccupations

When trying to increase the rat s emotionality in order to find out wheth the alteration thus induced would facilitate the initiation of mouse killing be havior one is obviously led to consider the behavioral effects of septal dama destruction of the septal forebrain was indeed shown by a number of investi tors to result in alterations often designated as septal hyperreactivity or septal rage that range from an increased responsiveness to tactile stimulat up to violent flight and attack reactions [Albert et al 1975 1976 Brady et a 1953 1955 Dominguez et al 1969 Douglas et al 1966 Fulton et al 19?9 Gage et al 1978a 1978b Harrison et al 1957 King 1958 1959 King et al 1958 Nielson et al 1965 Olton et al 1974 Philipps et al 1972 Reynolds 1965 Schnurr 1972 Seggie 1968 Singh 1969 Yutzey et al 1964] Several experiments however failed to produce such a septal rage consistently in rat [Burkett et al 1966 Clody et al 1969 Fried 1969 Krieckhaus et al 1964 Thomas et al 1959 Thomas et al 1972] as well as in cats [Bond et al 1957 Kling et al 1960 McCleary 1966 Moore 1964]

With regard to the initiation of muricide behavior the results reported are even more conflicting at least at first sight Karli [1960] and Malick [1970] found no increase in mouse killing behavior following septal lesions while Siegel et al [1969] as well as Miczek et al [1972] clearly demonstrated initiat of such behavior in septal lesioned rats This discrepancy could not be du to strain differences since Latham et al [1974] found an increase in mouse killi following septal damage in rats of the strain (Long Evans) used by Malick w they found no change in rats of the strain (Sprague Dawley) used by Miczek et al But other factors must be taken into account namely degree of prior ex perience with mice site and extent of lesion and moment of postoperatio testing

is highly probable that the lack of initiation of interspecies aggression f[ollowin]g septal l[e]sions reported by one of us [Karli 1960] was due to the fact th[at] the lesioned rats had been given prolonged experience with mice prior to the operation and that they had thus become familiarized with the presence of a m[o]use in their cage Indeed Vergnes et al [1976] showed in our laboratory that on the day following the septal lesion 60% of the rats would kill the very first mouse they were ever presented with whereas no more than 8% of those rats that had been given preoperative experience with mice would display the killing [be]havior

That site and extent of the produced lesion also play an important rol[e] is clearly illustrated by the results recently reported by Wallace et al [1978] In [thei]r study no effect on muricide was found following either damage restr[ic]ted to the septum or damage restricted to structures ventral to the septum Only [whe]n the septal damage invaded more ventrally located structures did they [ob]serve an increase in muricide It is worth adding that killer rats were found to [be si]gnificantly more irritable than nonkillers

Th[e] lesion induced hyperreactivity is known to lessen in progress of time [w]hen produced in the adult animal the septal syndrome is but a transient con[di]tion Even though it may persist for postoperative periods of up to 75 days [Kn]eckhaus et al 1964] it vanishes quite rapidly (in 5 14 days) if the lesioned [an]imals are handled regularly [Brady et al 1955 Reynolds 1965] According [t]o Gotsick et al [1972] the dissipation of the septal syndrome depends on the [d]istribution rather than on the amount of handling With re[g]ard to muricide [th]e data obtained by Miczek et al [1972] su[gg]est that there is a close correlation [b]etween the lesion induced hyperreactivity and the initiation of mouse killin[g] [be]havior Not only was the interspecies aggression displayed immediately follow[ing] the lesion of an affective kind but this lesion effect was also a transient [on]e and its time course paralleled more or less that of the septal ra[g]e syndrom[e] [si]nce none of the rats that were first retested 15 days after surgery (i[e] when [th]e lesion induced hyperemotionality had sharply d[ec]lined) killed any mi[c]e

In a recent paper dealing with behavioral effects of amygdaloid lesions [pe]rformed in both infant and adult rats [Eclancher et al 1979] we recall the [f]act that even though much sparin[g] of fun[c]tion has generally been observed [f]ollowing early damage to cortical stru[c]tures substantially less sparing has [ge]nerally been reported followin[g] early damage to brain stru[c]tures below th[e] [co]rtical level In the study mentioned early amygdaloid lesions (performed at 7 [da]ys or at 25 days) provoked a lasting hyperreactivity together with an increased [p]robability of occurren[c]e of muricide while amygdaloid lesions performed at [a]dult age had no such effe[c]t Wi[t]h re[g]ard to the effects of early septal dama[ge] [fr]om data con[c]ernin[g] the rat s general responsiveness have been reported [...] Endroczi et al 1969 Johns[o]n 1972 Janzen et al 1976 Molino 197[5] Phillips et al 197[3] Phillips et al 1972 Schoenfeld et al 1974 Stewart et al 1977] but to our knowledge no study has ever considered the question from

the point of view of muricide behavior Furthermore little is known about the possible influence of environmental factors upon behavioral ontogeny followin early brain damage

The present study was thus undertaken with the aim of clarifyin the follov ing questions

a What are the effects of septal lesions with regard to both the rat s re activity when facing an unfamiliar situation such as an open field and the probability of initiation of muricide behavior according as the septal dama e was produced in infancy (at the age of 7 days) or at adult age (at the age of 3 months)? In order to detect possible differential effects of early septal lesions the animals reactivity before and after puberty a first open field test was run a the age of 40 days Furthermore the spontaneous activity was recorded by means of an actograph in all septal lesioned animals in order to overcom some of the difficulties usually encountered when trying to interpret the rat s behavi in the open field

b When produced through early damage do the behavior chan es depend on size and extent of the septal lesion in the way they do when produced by damage carried out at adult age?

c To what extent do the behavioral effects of an early septal lesion depend on the environmental conditions in which the lesioned animals ar being raised *from weaning (either in groups or in social isolation)?*

d What are the lesion induced effects if any on body weight in th adult animal as well as on weight gain in the young animal? Since the possibility can never be ruled out that an observed behavior alteration might be due to a g nera defective condition it was of interest to regularly examine body wei ht and food intake In addition the weight of the testes and that of the adrenals we e checked in each animal at the end of the experiment

## METHODS

### Subjects

Data for this study were collected from 255 male albino Wistar rats taken from litters born in our laboratory At three days of age th pups were sex d o the basis of the anogenital space and the litters were cull d so as not to exceed 5–8 male pups per litter The split litter technique was used in selecting a mals for the septal and control groups Half of the pups in each litter und rwe t a septal lesion the other half underwent a sham lesion (control animals)

### Surgery and Histology

Septal lesions were produced in rat pups we ghing 11–15 gm at th ag of days The surgery was performed under sodium pentobarbital (Nembutal )

anesthesia (0 72 mg/10 gm) administered intraperitoneally using a La Précision Cinématographique stereotaxic instrument After incision of the scalp a 1 mm trephine was used to drill a hole in the cartilagenous skull An electrode insultated with epoxylite except for 0 5 mm at the tip was lowered at points specified in Table I The circuit was completed by connecting ear bars to the anode The lesion was produced by passing a 2 mA current for 10 sec at each point Sulfa powder was applied to the incision before suturing The ear of each animal was punched for identification and the rat pups were put back to the nest and were left there until weaning on postnatal day 25 At this age the lesioned rats were housed either individually or in groups of three or five rats per cage until 3 months old The same procedure was employed for the control animals except that no current was passed

The animals that were assigned to undergo a septal lesion at adult age were weaned at 25 days of age and raised in groups until 2 5 months old Surgery on these adult animals was performed at 3 months with Nembutal anesthesia (40 mg/kg IP) Stereotaxic coordinates are reported in Table I

A pilot study had been carried out prior to the actual experiments in order to determine the coordinates that would allow us to produce a complete destruction of the septum in the 7 day old rat pups and also those that would allow us to produce lesions additionally invading more centrally located structures (Table I)

At the end of the study all animals were killed by means of a lethal dose of Nembutal The brains were removed stored in 10% formalin for several days embedded in paraffin and sectioned at 20 μ Every fifth section was mounted on a slide and stained with cresyl violet Both adrenals and testes were removed carefully freed of connective tissue and fat then weighed

## General Procedure

All animals were weighed on the day of weaning and once weekly thereafter until termination of the experiment Animals that had been submitted to early septal lesions (at 7 days) as well as animals that were to be lesioned at adult age were tested in an open field at 40 days of age three days running

At 3 months of age those early lesioned and sham operated rats that had been grouped from weaning were housed in individual cages and rats that had been housed in isolation were put in another individual cage Three days after this change of home cage a mouse was introduced into the rat s cage during the light portion of the light-dark cycle Twenty four hours later either the mouse or its remains were removed from the cage The rat had never been previously in contact with a mouse Each rat was retested for its muricidal behavior once a week

Rats assigned to be lesioned at adult age were grouped from weaning until 2 5 months At this age they were housed individually and three days later they were tested in the open field on three successive days Surgery on these adult animals was performed at 3 months of age One day after surgery they were

**TABLE I Lesion Coordinates and Current Parameters for Septal Lesions in Infant and Adult Rats**

| Age | Lesion | Anterior to lambda (mm) | Lateral to lambda on either side (mm) | Below skull surface at the λ (mm) | Cathodal current: Intensity (mA) | Cathodal current: Duration (sec) |
|---|---|---|---|---|---|---|
| 7 days | *Septum* | 5 | 0 3 | 5 | 2 | 10 |
| | | 4 7 | 0 3 | 4 5 | 2 | 10 |
| | Septum + ventral structures | 5 | 0 3 | 5 | 2 | 15 |
| | | 4 7 | 0 3 | 5 1 | 2 | 10 |
| 3 months | Septum | 9 5 | 0 6 | 5 | 2 | 20 |
| | | | | 6 | 2 | 20 |
| | | 9 | 0 6 | 5 5 | 2 | 20 |
| | | 8 5 | 0 6 | 5 5 | 2 | 20 |
| | | | | 6 | 2 | 20 |

p sented for the first time with a mouse and three days later the rats were again tested in the open field

D n the fifth month after birth the food intake of each rat was controlled for three weeks At about 5 months of age spontaneous activity of all rats was measured for 24 hours in an actograph After that the animals were submitted to avoidance conditioning (Eclancher et al in preparation)

**Apparatus**

**Open field** The apparatus consisted of a transparent surrounding wall of Plexiglas (120 X 100 X 30 cm) lying on a white sheet subdivided into thirty 20 cm squares A lighting of 1 000 lux in the center of the open field and of 600-00 lux on the edges was provided by lamps placed above the field Animals ere always dropped in a corner of the open field During the three minutes of test the path covered by the animal was reproduced on a diagram exhibiting e floor of the field reduced to one tenth From this reproduction of the path llowed by the rat locomotor activity was measured by means of a curvometer number of rearings and the number of fecal boluses dropped during the ree minute observation period were also recorded

**Actography** Spontaneous locomotor activity was measured by placing the in an Animex apparatus (Farad Electronics Stockholm) for a period of 24 urs starting at 11 30 AM The principle consisted in the recording of changes duced by the animal s movements in an electromagnetic field these changes duced impulses that were summed up every ten minutes

**a Analysis**

A two way analysis of variance for unequal numbers was applied to all data individual comparisons were made with the Scheffe test only after the over nalysis provided evidence of statistically significant between group differences h regard to open field data an analysis of variance was performed on locomotor vity number of rearings and defecation scores as a function of the lesion on restricted to the septum or extending more ventally or sham lesion) of environment in which the rats had been maintained from weaning and also of a e at which the rats had been lesioned When a significant main effect revealed differences in means were evaluated with the Scheffe test The concerning activity measured in the actograph (means of the 24 hour nty and means of the activity hour by hour) were submitted to an analysis riance with lesion age of operation and postoperative environment as the factors An analysis of variance was performed on the means of body ht as well as the means of food intake When analyzing the percentage of r rats the chi square test (with Yates s correction when necessary) was to compare the different groups

## RESULTS

### Histology

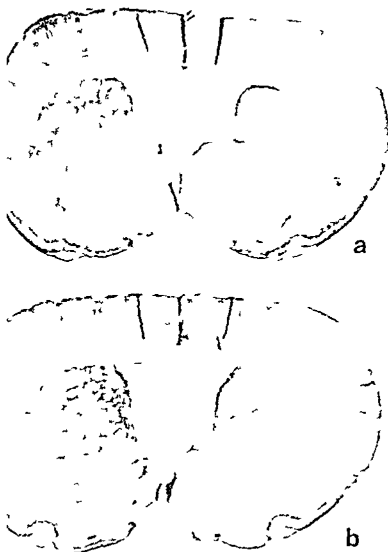
Of the 110 rats septalectomized at 7 days of age and assigned to be group reared (lesions restricted to the septum in 50 rats and larger lesions spreading to ventral structures in the 60 others) 64 died during the two weeks following the surgery In the 46 rats that survived and reached adult age having been raised in groups from weaning histology revealed eventually that a) three rats had to be discarded because the septum was not entirely destroyed b) 18 rats had undergone a complete destruction of the septum including medial and lateral septal nuclei (group 7 SG Fig 1a) c) 25 rats had undergone a larger lesion of the type shown in Figure 1b Structures involved were the lateral and medial septal nuclei the nucleus accumbens septi the diagonal bands the anterior commissure the columns of the fornix the nucleus triangularis septi and in some cases the superior part of the area preoptica medialis (group 7 SvG)

Of the 60 rats septalectomized at 7 days of age and assigned to be isolation reared 21 rats died before reaching the weaning age 10 rats died in the isolation cage 4 rats had to be discarded because of incomplete lesions 25 rats had undergone a complete destruction of the septum including medial and lateral septal nuclei with no spreading to more ventrally located structures (group 7 SI)

Of the 21 rats septalectomized at 3 months of age 19 had undergone a complete destruction of the septum that did not involve more ventrally located structures These rats had been raised in groups from weaning (group Ad SG) The lesions were comparable to those performed at 7 days of age in both group-reared and isolation reared rats A group of control rats had been sham operated at 7 days of age 22 rats being raised in groups from weaning (group 7 CG) and 31 rats being maintained in isolation from weaning (group 7 CI)

### Open Field

**In 40-day-old rats** For this group the analysis of variance showed no lesion effect on locomotor activity over the three days but an environment effect and a lesion X environment interaction [$F(1\ 81) = 6\ 93$ $P < 0\ 05$ on the second day $F(1\ 81) = 17\ 06$ $P < 0\ 01$ on the third day] (Fig 2) Individual group comparisons made with a Scheffé test revealed that early septal rats maintained in groups from weaning (7 SG) were more active than early septal rats maintained in isolation (7 SI) on the first day ($P < 0\ 05$) In contrast on the second day and on the third day the rats maintained in groups (7 SG) were less active than rats maintained in isolation (7 SI) ($P < 0\ 05$ and $P < 0\ 01$ respectively) This was due to the fact that ambulation activity of the 7 SG rats decreased drastically over the three days while activity of the 7 SI rats did not change from the first to the third day of the open field test




esentati e photomi rog aph of fr ntal se tions through the septum fr m
sust ined a lesion restri ted to the septum at 7 days of a e and b) a rat that
eptal l sion invad ng more ventrally located stru tures at 7 days of age

the third day [$F(1\ 78) = 5\ 80$ $P < 0\ 05$] Individual group comparisons made a Scheffé test revealed that rats that had sustained septal lesions in infancy and had been maintained in groups from weaning (7 SG) were less active at adult than sham-operated controls maintained in the same environment (7CG) on the first day ($P < 0\ 01$) and also than rats 7 SvG on the first day ($P < 0\ 05$) These septal rats lesioned in infancy (7 SG) were also significantly less active than septal rats lesioned in adulthood (Ad SG) on the second day ($P < 0\ 05$) and on the day ($P < 0\ 05$) However when the rats septalectomized at 7 days of age had maintained in isolation from weaning (7 SI) they were significantly more active at adult age than sham operated controls maintained in the same environment (7 CI) on the second day ($P < 0\ 01$) and on the third day ($P < 0\ 01$) When septalectomized in infancy rats maintained in isolation (7 SI) were reliably more active than rats maintained in groups (7 SG) on the second day ($P < 0\ 01$) and on the third day ($P < 0\ 05$) In the control groups on the other hand the group reared rats (7 CG) were reliably more active than the isolation reared rats (7 CI) on the first day of the open field test ($P < 0\ 05$)

Analysis of variance on the rearings made by the rats when adult revealed a significant lesion effect on the first day and on the third day [$F(2\ 78) = 4\ 41$ $P < 0\ 05$] but no age effect and no environment effect Individual group comparisons made with a Scheffe test revealed that on the first day the rats septalectomized in infancy and maintained in groups made significantly fewer rearings than the control rats maintained in groups on the first day ($P < 0\ 05$) and on the third day ($P < 0\ 01$) if the lesion was restricted to the septum Scheffé test also revealed that rats septalectomized in adulthood (Ad SG) made reliably fewer rearings on the third day than sham operated control rats ($P < 0\ 01$)

Analysis of variance on the number of boluses dropped in the open field revealed a lesion × environment interaction on the first day [$F(1\ 81) = 4\ 19$ $P < 0\ 05$) and an environment effect on the third day [$F(1\ 81) = 6\ 44$ $P < 0\ 05$) Individual group comparisons made with a Scheffé test revealed that on the first day the defecation scores were reliably higher in rats septalectomized (lesion restricted to the septum) at 7 days of age and maintained in groups (7 SG) than in control animals that had been sham operated at the same age and maintained in groups from weaning (7 CG) ($P < 0\ 01$) and that they were also reliably higher than in rats septalectomized at adult age (Ad SG) ($P < 0\ 05$) and higher than in rats operated in the same area at 7 days of age and maintained in isolation from weaning (7 SI) ($P < 0\ 05$) On the third day the rats 7 SI defecated significantly more than the rats 7 SG ($P < 0\ 05$)

In short septal lesions performed in 7-day old rats resulted at adult age (as has been observed at 40 days of age) in a reduced number of rearings in the open field The decrease in the number of rearings did not depend on environmental conditions nor did it depend on the age (7 days or 3 months) at which the lesion had been performed Ambulation activity displayed at adult age in the open field

b lesioned rats depended on the age at which the septal lesion had been p-f- med (rats lesioned at adult age did not show lower ambulation scores than d d controls if one considers the activity summed over the three days of the t-st) and on the environmental conditions in which the animals had been reared f om weanin (early septal group reared rats were less active than group reared ontrols while early septal isolation reared rats were more active than isolation eared controls) Concerning the defecation rate only rats septalectomized at 7 days of a e and maintained in groups had a high defecation rate on the first day f the open field test performed at adult age

A few major facts emerge from the data concerning the open field tests erformed at 40 days of age and at adult age In the first place it is worth noting at th ambulation activity significantly decreased from the first to the third y in rats sham operated at 7 days of age (7 CG and 7 CI) as well as in rats ptalectomized at 7 days of age and maintained in groups (7 SC and 7 SvG) bu this activity did not vary from the first to the third day in rats talectomized at 7 days of age and maintained in isolation (7 SI) nor in rats talectomized at adult age (Ad SG)

Furthermore there occurred a marked decrease between 40 days and 3 month a e in the ambulation activity on the first day of the test in control rats up-reared (7 CG) or isolation reared (7 CI) and also in rats 7 SG In contrast re was no significant difference between the activity measured on the first day 0 days of age and that measured on the first day at 3 months of age in rats G and 7 SI

Concerning the number of rearings on the first day of the test the analysis aled no reliable difference between 40 days and 3 months of age in the trol rats (7 CG and 7 CI) while a marked d crease was observed in rats alectomized at an early age (7 SG and 7 SI)

The defecation scores on the first day of the test decreased from 40 days to onths of age in septal rats 7 SG and 7 SI while they remained at the same l in control rats 7 CG and 7 CI

## graphy

he data on actography were submitted to an analysis of variance using lesion f operation and environment as the main fa tors (Fig 5) Total activity sured over 24 hours) was compared f r all animals with results showing a ble lesion effect (F(- 7o = 18 - P < 0 01) Scheffé tests revealed that total ity of rats septalectomized at 7 days of age (7 SG and 7 SvG) or at adult age SG) was significantly higher than total activity of control rats sham operated e same age (P < 0 01) When maintained in isolation the septal rats (7 SI) ad a higher total activity than control rats (7 CI) (P < 0 01)

e analysis of activity s res per hour revealed that imm diately after intro on of the rats into the activity cage (between 11 30 AM and noon) there

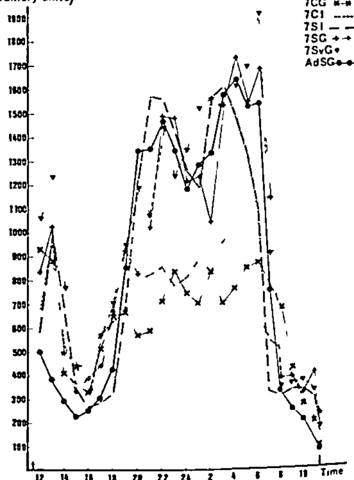



Fig. 5 Mean spontaneous activity measured for 24 consecutive hours beginning at 11 33 AM For symbols of experimental groups see Figure 2 For significant differences, see Results section

was no lesion effect but a reliable age effect and a reliable environment effect Scheffé tests revealed that rats septalectomized at adult age (Ad SG) were significantly less active than rats septalectomized at 7 days of age (7 SG) ($P < 0.01$) and significantly less active than control rats ($P < 0.01$) Furthermore control rats maintained in groups (7 CG) were more active than controls maintained in isolation (7 CI) ($P < 0.05$) Septal rats maintained in groups (7 SG) were more active than septal rats maintained in isolation (7 SI) ($P < 0.05$)

On and after 8 00 PM and until 6 00 AM rats septalectomized at an early age were more active than control rats sham operated at the same age irrespective of whether they had been group reared ($P < 0.05$) or isolation reared ($P < 0.05$) Rats septalectomized in adulthood were also more active than control rats during this period of time ($P < 0.05$)

The Scheffe tests revealed no significant difference between groups from 8 00 AM until 11 00 AM and this is precisely the period of the day during which the open field tests were performed So differences observed with regard to the animals behavior can hardly be due to differences in their spontaneous activity

### Mouse Killing Behavior

Of the 18 rats septalectomized at 7 days of age (lesion restricted to the septum) and group reared from weaning (7 SG) 10 (56%) displayed mouse killing behavior Four animals killed the mouse within the first five minutes while six others killed during the night (four of the latter rats stopped killing after about one month) Eight rats never killed the mouse introduced in the home cage Only one of the 11 sham operated rats maintained in groups (7 CG) proved to be a killer rat (9%) The 7 SG rats thus showed a significantly higher percentage ($\chi^2$ with Yates s correction = 4 44) of muricidal responses than did the control animals (7 CG)

Of the 25 rats septalectomized at an early age (with a lesion extending to ventral structures) and maintained in groups (7 SvG) nine (36%) displayed mouse killing behavior Six rats killed the mouse within five minutes following the introduction of the mouse while three others killed during the night The comparison of the proportion of killer rats in group 7 SvG and group 7 SG respectively did not reveal any significant difference ($\chi^2 = 1.62$) Like the 7 SG rats the 7 SvG rats exhibited a significantly greater percentage of muricidal behavior ($\chi^2$ with Yates s correction = 8 93) than did the control rats maintained in groups (7CG)

Of the 25 rats septalectomized at 7 days of age and maintained in isolation (7 SI) 13 rats (52%) killed the mouse introduced in their cage mostly during the night The comparison of this percentage with the percentage of killers in 7 SG rats revealed no significant difference ($\chi^2 = 0.05$)

Ten of the 31 (32%) sham operated rats maintained in isolation (7 CI) displayed muricide behavior either within five minutes following the introduction of the mouse into the rat s cage or during the night They showed a reliably higher percentage ($\chi^2$ with Yates s correction = 5 85) of muricidal responses than did the control rats maintained in groups (7 CG) While the percentage of killers in rats septalectomized and maintained in isolation (7 SI) was higher than the percentage of killers in isolation reared control rats (7 CI) the $\chi^2$ test revealed no reliable difference ($\chi^2$ = ? 24)

In the group of rats septalectomized at adult age ten of 17 animals (59%) displayed mouse killing behavior most of them killing the mouse during the night the others killing almost immediately This percentage does not significantly differ from the percentage of killer rats in the 7 SG group ($\chi^2$ = 0 04)

### Body Weight and Weight of Adrenals and Testes

Analysis of variance computed on body weight (Fig 6) over 15 weeks (post natal weeks 5–19) revealed a reliable lesion effect until the tenth week of age Scheffe tests revealed that the body weight of animals septalectomized at 7 days of age (lesion restricted to the septum or lesion also invading more ventrally located structures) and maintained in groups was reliably lower than the body weight of control rats sham operated at the same age and maintained in groups ($P < 0.05$) Scheffe tests also revealed that during the period following the septalectomy in the adult animal ie 15–17 weeks of age the Ad SG rats had a body weight significantly lower than that of control rats ($P < 0.01$)

Concerning the weight of the adrenals and testes (Table II) the analysis showed an age effect [$F(1\ 67) = 4.51$ $P < 0.05$ for the adrenals $F(1\ 67) = 28.4$ $P < 0.01$ for the testes] Scheffé tests revealed that rats septalectomized at adult age (Ad SG had heavier adrenals and testes than did control rats ($P < 0.05$ and $P < 0.01$) as well as rats septalectomized at 7 days of age and maintained in groups (7 SG) ($P < 0.05$ and $P < 0.01$)

### Food Intake

Analysis of variance on the data concerning daily food intake (Table II) measured at adult age revealed a lesion effect [$F(2\ 69) = 6.91$ $P < 0.01$] and an environment effect [$F(1\ 65) = 4.65$ $P < 0.05$) Scheffe tests revealed that the food intake of rats septalectomized at 7 days of age and maintained in groups (7 SG) was reliably higher than food intake of control rats ($P < 0.01$) and food intake of rats 7 SiG ($P < 0.01$) Food intake of rats septalectomized at adult age (Ad SG) was significantly higher than that of control rats (7 CG) ($P < 0.01$) Moreover rats septalectomized in infancy ate more per day when group-reared than when isolation reared ($P < 0.01$)

## DISCUSSION

First of all it appears that septal lesions performed in infancy have a lasting effect upon juvenile and adult behavior Lowered rearing scores in the open field were already observed at the age of 40 days when locomotor activity (summed over the three days of the test) and defecation scores seemed to be unaffected As a matter of fact the early septal lesion had an effect on locomotor activity since it entailed a deficient habituation provided that the lesioned animals were raised in isolation from weaning until the age of 40 days

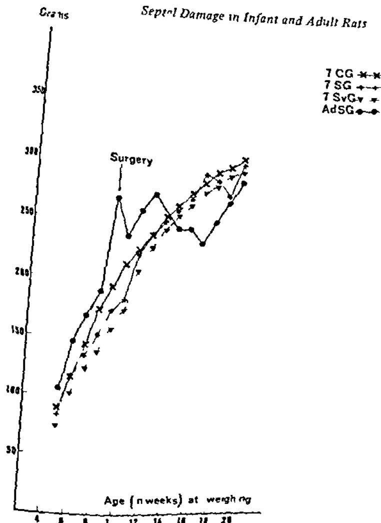



Fig 6 Body weight in septal rats and control rats. For symbols of experimental groups see Figure 2. For significant differences see Results section

When tested in the open field at adult age early septal rats group reared from weaning displayed less locomotor activity than did control rats or rats septalectomized at adult age. Once again when raised in isolation from weaning early lesioned rats showed a clearly deficient habituation in comparison with the group reared septal rats

Sham operated rats reared in isolation (7 CI) were less active than group-reared control rats (7 CG) on the first day of the open field test. Just after being

**TABLE II Food Intake and Weight of the Adrenals and of the Testes in Septal Rats and Control Rats (Mean ± SE)**

| Rats | Food intake (gm) per day | Weight of adrenals (mg/100 gm body weight) | Weight of testes (mg/100 gm body weight) |
|---|---|---|---|
| 7 CG | 21 5 ± 2 0 | 13 4 ± 2 8 | 772 9 ± 110 ? |
| 7 SG | 23 7 ± 2 5 | 13 1 ± 3 7 | 753 7 ± 89 5 |
| 7 SvG | 21 5 ± 1 7 | 12 3 ± 2 7 | 759 7 ± 87 3 |
| Ad SG | 24 7 ± 2 3 | 15 3 ± 2 7 | 942 5 ± 108 6 |
| 7 CI | 23 2 ± 2 3 | 13 3 ± 2 1 | 7?? 5 ± 83 7 |
| 7 SI | 21 2 ± 2 1 | 13 7 ± 1 8 | 779 5 ± 10? 6 |

introduced into the actography ie during the initial period that can be considered to correspond to the exploration of a novel environment isolation reared animals (whether septalectomized or sham operated) also proved less active than group reared animals According to Sahakian et al [1977] isolated rats initiate exploratory sequences of behavior more often than controls but terminate th m sooner

In contrast with rats septalectomized in infancy and then group reared from weaning those lesioned at adult age did not show lower ambulation scores than the group reared control rats if one considers the locomotor activity summed over the three days of the open field test As a matter of fact this apparent absen of lesion induced change results from two effects that compensate each other namely a lowered activity on the first day of the test and a deficient habituation on the following days

A number of contradictory conclusions have been stated in the literature with regard to the effect of septal lesions on the rat s activity in various situations Wallace et al [1978] found that damage restricted to the septum does not cause a reduction in horizontal activity ie in the number of squares crossed A de creased activity in the open field following septal lesions was reported by s m authors [Corman et al 1967 Mos et al 1977 Schwartzbaum et al 1966] A lesion induced decrease in activity was also found in activity ca es [Gage et al 1975] in running wheels [Clody et al 1969 Douglas et al 1966 Gotsi k 1969 Nielson et al 1965] and in home cages [Thomas et al 1959 Zu ker 1965] In contrast a lesion induced increase in activity was found in open fi ld tests [Donovick et al 1969 Douglas et al 1966 Woodruff et al 1976] in mazes [Nielson et al 1965 Thomas et al 1959] and in other novel environ ments [Corman et al 1967 Gotsick 1969]

Such contradictions can be overcome only if one considers both the degre of familiarity with the test situation and the length of the period of tim over which the activity is being summed This statement may well be exempl f d by

the behavior of our septal animals when submitted to 24 hour actography During the initial exploration period rats lesioned in infancy were rather less active and those lesioned at adult age were clearly less active than sham operated control animals while they all showed clearly higher activity scores than controls later on ie during the night One may thus assume that septal lesions result in increased activity levels when the situation is not too unfamiliar to the animal and/or when changes are introduced into familiar environments (we noticed that all septal rats tried to escape *from their home cage every time* the lid was raised) while a decreased activity is noted in unfamiliar situations and especially when the test is carried on for a short time only

Whatever the age (7 days or 3 months) at which the rats had been septalectomized they exhibited lower rearing scores in the open field than did controls irrespective of the environmental conditions in which they had been reared from weaning This decreased vertical activity (rearing) is in agreement with the findings of Beatty et al [1975] Dirlam [1969] Kemble et al [1975] and Wallace et al [1978] following septal lesions carried out in the adult rat

Defecation in the open field was differentially affected according to the age at which the septal damage occurred Rats lesioned in infancy and reared in groups from weaning defecated more than controls on the first day of the open field test carried out at the age of 3 months while septal lesions performed in adulthood did not result in any reliable change in defecation rate It is often assumed that activity and defecation in the open field reflect the rat s emotional reactivity More specifically high activity and low defecation are thought to reflect low emotionality while low activity and high defecation are associated with high emotionality When comparing the effects of septal damage in group-reared animals it appears that on the first day of the open field test a reduced ambulation activity was observed both after an early lesion and after a lesion performed at adult age (though less so in the latter case) while a significant increase in defecation was found only in early lesioned rats On the other hand a deficient habituation over the three days of the test was observed in animals lesioned at adult age but not in group reared animals that had undergone the septal lesion in infancy

It is worth adding however that irrespective of whether the lesioned induced syndrome (decreased ambulation on the first day increased defecation on the first day deficient habituation over the three days) was complete or not all septalectomized rats *were clearly distinguishable* from controls by the vigor and persistence of their escape response and their reaction to capture When taken from their home cage and handled all septal rats reacted quite vigorously using their hind legs to push away the experimenter s hand but after being patted for a short while they be ame docile (more so than controls) submissive and placid On the following day however *the septal rats were again quite reactive* to any attempt to catch them

**TABLE II Food Intake and Weight of the Adrenals and of the Testes in Septal Rats and Control Rats (Mean ± SE)**

| Rats | Food intake (gm) per day | Weight of adrenals (mg/100 gm body weight) | Weight of testes (mg/100 gm body weight) |
|---|---|---|---|
| 7 CG | 21.5 ± 2.0 | 13.4 ± 2.8 | 77[illegible].9 ± 110.[illegible] |
| 7 SG | 23.7 ± 2.5 | 13.1 ± 3.7 | 753.7 ± 89.5 |
| 7 SvG | 21.5 ± 1.7 | 12.3 ± 2.7 | 759.7 ± 87.3 |
| Ad SG | 24.7 ± 2.3 | 15.3 ± 2.7 | 94[illegible].5 ± 108.6 |
| 7 CI | 23.2 ± 2.3 | 13.3 ± 2.1 | 7[illegible]2.5 ± 83.7 |
| 7 SI | 21.2 ± 2.1 | 13.7 ± 1.8 | 779.[illegible] ± 10[illegible].6 |

introduced into the actography, ie during the initial period that can be considered to correspond to the exploration of a novel environment, isolation reared animals (whether septalectomized or sham-operated) also proved less active than group reared animals. According to Sahakian et al [1977], isolated rats initiate exploratory sequences of behavior more often than controls but terminate them sooner.

In contrast with rats septalectomized in infancy and then group reared from weaning, those lesioned at adult age did not show lower ambulation scores than the group reared control rats if one considers the locomotor activity summed over the three days of the open field test. As a matter of fact, this apparent absence of lesion induced change results from two effects that compensate each other, namely a lowered activity on the first day of the test and a deficient habituation on the following days.

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Such contradictions can be overcome only if one considers both the d[illegible] of familiarity with the test situation and the length of the period of time over which the activity is being summed. This statement may well be exe[illegible]

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The lasting hyperemotionality that resulted from early septal damage contrasts with the rather transient character of the hyperemotionality that was ofte reported following septal damage in the adult rat [Ahmad et al 1968 Brady et al 1953 Corman et al 1967 Fried 1973 Gotsick et al 1972 Hammond et al 1971 Singh 1969 Slotnick et al 1973] The effects resulting from early septal damage seem to depend on both the sex of the lesioned animals and the a e at which the lesion was carried out Endroczi et al [1969] found no chan e in emotionality in rats septalectomized on the third postnatal day when compared with controls at 2 months of age Stewart et al [1977] reported that the emotionality scores were highest immediately after a septal lesion performed at the age of 25 days and that they fell to near control levels by 40 days of age On the other hand Phillips et al [1973] observed increased emotionality in female rats but not in males following septal lesions performed at 25 days According to Phillips et al [1972] septal lesions produce a very transient (up to three days) hyperemotionality when carried out in prepubertal male rats (30–4 days of age) whereas similar lesions result in sustained hyperemotionality (up to 21 days) when carried out in postpubertal animals (45–55 days of age)

Our finding that the behavioral effects of early septal lesions limited to the septum are similar to those of lesions invading more ventrally located structures fails to replicate the findings of Turner [1970] and of Thomas et al [197?] following septal lesions performed at adult age These authors presented strong evidence that lesions of the septum alone were not sufficient to produce an increased irritability and that lesions located in and below the horizontal plane of the anterior commissure were necessary for such an increased irritability to appear On the other hand Paxinos [1975] reported that destruction of the region ventral to the septum even though necessary was not sufficient for the appearance of an increased irritability and he suggested that it was some interaction effect of damage in both areas (septum and the ventral region) that actually produced such an effect

Concerning body weight the septal lesions had disruptive effects on weight gain whether they were performed at adult age or in infancy The latter finding contradicts the results of Johnson [1972] but corroborates those of Molino [1975] who found disruptive effects on body weight after septal l sions performed at 10 days of age The transient deficit in wei ht gain was not d to hypophagia since the control of food intake revealed that the rats lesioned in infancy as well as those lesioned at adult age actually ate more than control rats There is an apparent contradiction between a reduced body weight and an increased food intake It must be recalled however that the septal rats displayed a markedly enhanced spontaneous activity during the night Our results are con-

tent with those of Stoller [1972] who found an increase in food consumption in septal rats while their body weight was below the body weight of controls

Concerning the weight of adrenals and testes it appears that rats septalectomized at adult age have heavier adrenals and testes than control rats and rats lesioned in infancy. Although some dichotomy may exist between the size of the adrenals and their functional capacity [Mangili et al 1966] changes in adrenal weight are useful in assessing the response of rodents to stress [Christian et al 1964]. Increased adrenal functions following septal damage were found by Endröczi et al [1960] in the cat and by Bohus [1961] in the rat. Usher et al [1967] found an increase in adrenal weight in rats stressed following septal lesions. Montgomery [1968] obtained adrenal enlargement in septal rats in response to excessive handling or to provocations during behavioral testing. Whichever the origin of such an enlargement of the adrenals (direct interference with the functioning of the pituitary adrenal axis or increased activation of pituitary adrenal functions relating to the increased emotionality or both) normal weight of the adrenals is recovered by the animals that have undergone a septal lesion in infancy. The same holds true with regard to testicular weight. Since septal lesions performed at adult age affected the weight of the testes as was also found by Kling [1964] while early septal lesions did not.

As regards mouse killing behavior all septal lesions clearly increased the probability of its occurrence in the adult rat irrespective of whether the lesions were performed in infancy (at 7 days) or in adulthood (at 3 months) and irrespective of whether the animals were group reared or isolation reared from weaning. The increased probability of muricidal responses following septal damage performed in adulthood corroborates the findings of Siegel et al [1969] Miczek et al [1972] and Latham et al [1974]. It is worth adding that in rats lesioned in infancy the mouse killing behavior proved to be rather unstable as was reported with regard to septal damage performed at adult age. Some rats stopped killing mice for some time and then started killing again.

The discrepancies that exist in the findings relative to the effect of septal damage on interspecific aggressiveness depend on a number of factors.

1 Whether a rat will kill a mouse on the first postoperative test depends in part on the time of postoperative testing since less killing occurs at longer postoperative delays. The longer delay used for testing septal rats could at least partially explain the low percentage of killer rats obtained by Miley et al [1972]. Indeed Miczek et al [1972] found that on the first postoperative day the septal rats displayed increased fighting in response to shock and that muricide was prevalent. About ten days following surgery both these effects began to disappear and they were no longer found by postoperative day 15. Such a parallel

evolution suggests that increased reactivity and increased probability of atta k are causally related contrary to the conclusions of Ahmad et al [1968]

2 Extensive exposure to mice prior to septal surgery may entail a stable in hibition of the mouse killing behavior so that killing following the lesion does not occur [Miley et al 1972 Penot et al 1976] This explains why no muric[illegible] was observed in septal rats that had been given prolonged experience with mice prior to the operation [Karli 1960]

3 The length of the muricidal test may also account for some discre[illegible] results The test employed by Malick [1970] was short (five minutes) and th[illegible] may explain the lack of increase in muricide that he observed following septal damage Most experimenters have used longer tests and Ra[illegible]er et al [1977] ha[illegible] emphasized the importance of the test length

4 Site and extent of the septal lesion may also affects its outcome with re gard to muricide But contrary to the report of Wallace et al [1978] who fo[illegible] that septal damage performed in the adult rat results in increased *muric[illegible]* if it extends to more ventrally located structures we found in the present st[illegible] that early septal damage had the same outcome with regard to mouse killi[illegible] behavior whether the lesion was restricted to the septum or invaded ventral structures in addition

As recalled above familiarization with mice results in a rather stable inh[illegible] of mouse killing behavior Since septal lesions do not abolish this kind of [illegible] while corticomedial amygdaloid lesions do have such an effect [Eclancher et al 1975 Karli et al 1977] one can conclude that the septum is not an ess[illegible] link in the chain of mechanisms through which social interactions with m[illegible] sult in a stable inhibition of muricide But inhibition of muricid[illegible] can als[illegible] re[illegible] from interactions with conspecifics This was observed previously in rats that h[illegible] undergone a removal of the olfactory bulbs [Karli et al 1974] In the pres[illegible] study the incidence of muricide in group reared controls was reliably lower than in isolation reared controls The fact that this difference was no lon[illegible] obs[illegible] in septal rats suggests that the septum is somehow involved in the m[illegible] through which interactions with conspecifics result in a suppression of m[illegible] (by an overall negative reinforcement of aggression?) In other wor[illegible]s, even [illegible] *a brain lesion provokes an increased probability of occurrence of mous[illegible] k[illegible]* behavior one has to take account not only of a possible increase in ge[illegible] reactivity and/or emotionality but also of a possible interferen[illegible] w[illegible] h [illegible] velopment and/or maintenance of a more or less stable inhibition of m[illegible] resulting from interactions with mice or with conspecifics

In many respects the behavior of rats septalectomized at 7 days of a[illegible] closer to that of rats septalectomized at adult age than to that of sha[illegible] control rats In other words there occurred no total sparing of fu[illegible] an early septal damage The sparing of function that actually o[illegible] on the environmental conditions in which the lesioned animals were rea[illegible]

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\GGRESSIVE BEHAVIOR
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# Maternal Aggression in Mice. The Non-Specific Nature of the Exteroceptive Maintenance by Young

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Five hours of pup removal during early lactation (Postpartum Day 6) reduced maternal aggression in mice while placement of the dam s entire litter (six pups) or a single pup behind a double wire mesh partition in the homecage maintained aggression at a level identical to that of mothers in direct contact with their young When placed behind the partition unfamiliar 6 13 and 0-day-old pups but not 30-day old mice maintained the behavior as effectively as the dam s own young The relationship of the findings to communal rearing conditions in the mouse is discussed

Key words mice maternal aggression young exteroceptive stimuli

## INTRODUCTION

Maternal aggressive behavior has been observed in many mammalian species for both confined and free ranging conditions [cf Rheingold 1963 Hafez 1969] Recent controlled laboratory studies in mice have begun to unravel the mechanism(s) controlling the behavior [Svare 1977]

Several lines of evidence indicate that nipple growth and the presence of suckling stimulation from young are prerequisites for the initiation of maternal aggression First females that are thelectomized (nipples removed) prior to

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parturition and that are continuously fostered young following delivery and males whose young are removed following parturition each fail to exhibit fi. behavior [Gandelman and Svare 1974 Svare and Gandelman 1976a] Secon virgin females which lack the nipple growth that normally occurs durin pre nancy fail to show maternal aggression following repeated exposure to youn [Svare and Gandelman 1976b] Third virgin females can be induced to exhil maternal aggression by treatment with a hormone regimen that induces nippl growth (19 daily injections of 500 $\mu$g progesterone and 0 02 $\mu$g estrogen) foll by suckling stimulation from foster young [Svare and Gandelman 1976b] Fourth hormone primed virgin females like pregnant and normal parturient males are nonaggressive prior to suckling exposure and fail to exhibit aggressi following either the removal of young or following thelectomy combined wit the presentation of foster young [Svare and Gandelman 1976b] Fifth hyste tomy and the fostering of young on or before Day 12 of gestation (the norma gestation period of the mouse is 18 days) a time at which nippl growth is no maximal and pup attachment does not take place does not result in fighting b havior [Gandelman and Svare 1974 Svare Bartke and Guislin 1978] Finally terectomy and the fostering of young after Day 13 of gestation a time at whi ple growth is adequate for pup attachment results in normal numbers of anim fighting [Gandelman and Svare 1974 Svare et al 1978]

While suckling is clearly involved in the initiation of aggression and perhaps the declining intensity of fighting with advancing lactation [Svare 1977] it m not be needed for the short term maintenance of fighting behavior This is sug gested by our findings showing that removal of young for 5 hours from the ho cage during early lactation (Postpartum Day 6) eliminates aggression whereas l placement of young behind a wire mesh partition in the dam s homecage for th same period of time maintains the behavior [Svare and Gandelman 1973] Qu tative and quantitative assessments of maternal aggressive behavior were lackin in the above study (only the presence or absence of fighting was observed) thu leaving in doubt whether exteroceptive stimuli from young are really as effectiv in maintaining aggressive behavior as direct contact with pups In addition a nu ber of other questions remain to be answered concerning the specificity of the pup-related stimulus involved in the exteroceptive maintenance of aggressi n

In the first experiment we sought to answer the following questions a) Is th maternal aggressive behavior exhibited by lactating females maintained in t presence of nonphysical contact with young qualitatively and quantitatively sim ilar to that of animals in direct contact with their young? b) Are unfamiliar you as effective as the mother s own young in maintaining the behavior in the absen of direct physical contact? c) Is one pup as effective as the dam s entire litter in the exteroceptive maintenance of the behavior?

## EXPERIMENT 1

### Method

Pregnant primiparous Rockland-Swiss (R–S) albino mice 70–80 days of age were housed individually in 11 X 7 X 5 translucent cages the floors of which were covered with wood shavings The mice had free access to food (Purina Laboratory Chow) and water and were maintained on a 12/12 hr light/dark cycle with lights on between 7 am and 7 pm Behavioral testing began at 3 pm

Screening of animals for maternal aggression was necessary because 20% of lactating R–S mice do not exhibit the behavior Thus on Postpartum Day 5 (litters had been adjusted to six pups on the day of parturition) an adult male R–S mouse that had been group housed with five other cage mates was introduced into the homecage of each dam 3 min after the removal of its young The young were removed to prevent them from being trampled upon during the fighting test This period of pup removal which was also used on subsequent tests has been shown not to influence maternal aggression [Gandelman 1972a] The lactating animal was scored as exhibiting aggression if it attacked (ie bit and chased) the intruder during the 3 min test The intruder animal was removed as soon as an attack was observed Intruder animals rarely if ever attack lactating animals nor do they fight back in response to being attacked [cf Svare 1977]

At 9 am on Postpartum Day 6 75 lactating animals that had exhibited maternal aggression during the screening tests were randomly divided into 5 groups of 15 animals (The Postpartum Day 6 was selected for study because by this time R–S mice exhibit peak levels of maternal aggression and because the exteroceptive maintenance of the behavior by young is fully functional [Svare and Gandelman 1973 Svare 1977]) The aggressive behavior of the lactating females was assessed following 5 hours of either pup removal (Group Removed) direct contact with their own young (Group Own-contact) placement of all of their own pups behind a double wire mesh partition extending 3 inches from the short wall of the homecage (Group Own partition) removal of all but one pup which was placed behind the partition (Group 1 – own partition) or removal of the mother s own young followed by the placement of a litter of similar age unfamiliar pups behind the partition (Group Unfamiliar partition) Three minute aggression tests were conducted in the homecages as previously described with the exception that the fighting was allowed to continue and the number of attacks were recorded

### Results

As seen in Table 1 5 hours of pup removal dramatically reduced maternal aggression while non physical contact with young for the same period regardless of

TABLE I Aggressive Behavior of Lactating Rockland Swiss Albino Mice Maintained in the Presence of Nonphysical Contact With Their Own or Unfamiliar Young of Different Ages

| Experiment | Group | Proportion and % fighting | Median (and ran attacks |
|---|---|---|---|
| 1[b] | Removed | 5/15 (33)[a] | 7 0 (3–17) |
| | Own–contact | 15/15 (100) | 20 0 (8–4?) |
| | Own–partition | 15/15 (100) | 16 0 (3–?8) |
| | 1–own–partition | 14/15 (93) | 15 0 (2–31) |
| | Unfamiliar–partition | 14/15 (93) | 15 5 (?–33) |
| 2[c] | 6–partition | 15/15 (100) | 13 0 (5–31) |
| | 13–partition | 15/15 (100) | 16 0 (2–27) |
| | 20–partition | 13/15 (87) | 10 0 (?–?4) |
| | 30–partition | 4/15 (27)[a] | 6 0 (5–?7) |

[a]Significantly different from all groups ($P < 0\ 01$)

[b]The aggressive behavior of lactating females towards an adult male follov ing 5 hr of either pup removal (Group Removed) direct contact with thei own young (Group Own–contact) replacement of all of their own pups b hind a wire mesh partition in the homecage (Group Own–partition) re moval of all but one pup which was placed behind the partition (Group 1- own–partition) or removal of the mother s own young followed by the immediate placement of a similar aged litter of unfamiliar pups behind the partition (Group Strange–partition)

[c]Lactating animals had their own young removed and then were proffered either a single 6 13 20 or 30-day-old mouse behind a double wire mesh partition in the homecage Testing for aggressive behavior toward an adult male was conducted 5 hr later

the quality (own or unfamiliar) or quantity (1 or 6 pups) of the pup related s uli maintained maternal aggressive behavior in a manner identical to that of l tating animals in direct contact with their young Chi square tests revealed si icant group differences in the proportion of animals fighting ($\chi^2(4) = 44\ 7$ P 0 001) Significantly fewer animals fought in Group Removed than in any oth group ($\chi^2(1) \geq 9\ 19$ $P < 0\ 01$) Moreover a Kruskal Wallis One Way Analysis Variance Test showed that the intensity of fighting behavior was not different influenced by the treatment conditions ($H(4) = 4\ 79$ $P > 0\ 05$) A Mann Wh it U Test showed that the intensity of fighting behavior displayed by the small n ber of animals fighting in Group Removed was significantly lower than that of Group Own–contact ($U = 9\ 5$ $P < 0\ 05$)

Our observations of maternal aggression revealed that the animals of the dif ferent groups were qualitatively similar in their behavior Attacks were immed

(neraain less than 3 sec) with biting directed toward the flanks and neck of the rtruder Ano genital sniffing and tail rattling frequently were seen between ttacks but never as a prelude to the initial attack Intruder animals never initiated tack against the lactating animals and never responded to attack by fighting ack

The above findings suggest that the stimulus from young responsible for the ; roceptive maintenance of aggression may be nonspecific in that unfamiliar ps are as effective as the mother s own young in maintaining the behavior In e next experiment we further examined the specificity of the exteroceptive p-related stimuli by analyzing the aggressive behavior of lactating animals untained in non physical contact with unfamiliar pups of different ages Be ise aggressive behavior begins to wane by Postpartum Day 8 and is virtually sent by Postpartum Day 15 [cf Gandelman 1972a Svare and Gandelman 73 St John and Corning 1973] we predicted that the ability of pups to e oceptively maintain maternal aggression would diminish with advancing

## PERIMENT 2

### thod

Sixty lactating female mice that exhibited maternal aggression during the 'ening tests as previously described were randomly divided into 4 groups of animals each On Postpartum Day 6 the animals own young were first re /ed and in their place we proffered either a single (Group 6–partition) 13 oup 13–partition) 20 (Group 20–partition) or 30 (Group 30–partition) old mouse behind a double wire mesh partition in the homecage Aggression s were conducted 5 hours later according to the procedure outlined in Experi it 1

### ults

he results showed that nonphysical *contact* with a single 6 13 or 20-day-old for 5 hours maintained maternal a gressive behavior at near normal levels npare with Groups Own–contact and Own–partition of Experiment 1) while lar exposure to a 30-day-old animal *did not* maintain the behavior (compare Group Removed of Experiment 1) (see Table I) Chi-square tests showed ificant group differences in the number of animals exhibiting aggression ($\chi^2(3)$ 5 $P < 0\ 001$) Significantly fewer animals exhibited aggression in Group 30–ition than in any other group ($\chi^2(1) \geq 8\ 69$ $P < 0\ 01$) Differences among the ps in the number of attacks were not statistically significant (Kruskal Wallis )VA Test $H(3) = 3\ 45$ $P > 0\ 05$) The above findings further suggest that the ulus from young responsible for the exteroceptive maintenance of aggression

may be relatively nonspecific in that unfamiliar pups ranging from 6–20 days of age are also effective in maintaining the behavior

## DISCUSSION

The present study confirms our previous findings [Svare and Gandelman 1973 Svare 1977] by demonstrating that direct physical contact with young is not a prerequisite for the short term maintenance of maternal aggression in lactating mice The removal of young for 5 hours from the homecage during early lactation (Postpartum Day 6) eliminates aggression while the placement of young behind a wire mesh partition in the dam s homecage maintains the behavior (Experiment 1) The current data extend the initial reports by showing that the quality (topography) and quantity (number of attacks) of aggression exhibited by lactating animals maintained in nonphysical contact with young is identical to that of dams left in direct contact with their pups

Our findings also show that the pup related stimulus responsible for the exteroceptive maintenance of aggression is relatively nonspecific When placed behind a wire mesh partition in the homecage unfamiliar young between 6 and 20 days of age but not 30 days of age maintain aggressive behavior during early lactation as effectively as the dam s own young (Experiments 1 and 2) Moreover one pup is as effective as the dam s entire litter in maintaining the behavior (Experiment 1) The function of these adaptations may be to ensure the protection and survival of unfamiliar young as well as pups that inevitably become separated from the nest and from their littermates as they grow older The fact that wild and laboratory reared mice exhibit communal rearing of young [Crowcroft and Rowe 1963 Gandelman et al 1970] would almost require the existence of such an adaptation However it is somewhat paradoxical that older pups possess the cues necessary for the exteroceptive maintenance of maternal aggression since it is well known that the behavior is absent after Postpartum Day 15 [Gandelman 1972a Svare and Gandelman 1973 St John and Corning 1973]

This striking lack of synchrony between the mother s changing behavior and the sensory cues provided by young is difficult to explain It is well known that 6–20-day-old mice are defenseless and readily attacked by adults [Gandelman 1972b Svare Bartke and Macrides 1978] while 30-day-old animals begin to become more independent and to take on the behavioral and physical characteristics of adults [cf Williams and Scott 1953] Thus in a communal situation it would seem adaptive for at least some females (early lactating) to be responsive to the aggression maintaining cues of older but still defenseless pups This interpretation requires us to invoke a theory of "division of labor" in the mouse social organization wherein one of the primary duties of the recently parturient animal would be to defend young while that of late lactating animals would be to perform other important functions (ie foraging for food) Further studies of ma

nal a ression in communal situations clearly are necessary in order to support fate the above interpretations

An issue not addressed in the present experiments concerns the mechanism onsible for the exteroceptive maintenance of aggression Because smell plays a dominant role in modulating rodent social behavior and endocrine func [cf Doty 1976] we have speculated elsewhere that olfactory cues from n sustain maternal aggres ion by maintaining the release of circulating hor es in the dam [Svare 1977] Regardless of the mechanism involved the pres indings indicate that the sensory cue from young is age-dependent (ie it is by 30 days of age) and is not specific to the mother s own young

ecent reports indicate that approach behaviors and home orientation by the g are controlled in part by exteroceptive stimuli (pheromones) emitted by nother [Porter et al 1976 Breen et al 1977] The present findings as well vious reports [Svare et al 1973 Svare 1977] indicate that the converse of nay also be true namely exteroceptive stimuli from young guide the pro e behavior displayed by the mother

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Volume 5 pages 425—435

# ι Cross-Cultural Study of Rape

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Rape is often considered a crime and as such is subject to punishment. This paper reports a test of a deterence theory" of rape with a cross-cultural study which uses a sample of societies drawn from the Human Relations Area Files. Fraternal interest group theory is also tested This theory argues that the presence of fraternal interest groups power groups of related males predicts the occurrence of rape in a society Although the results support both theories a composite theory using both deterrence and fraternal interest group theor es, was found to provide a better explanation for the occurrence of rape than either theory alone

Rape the act of having sexual intercourse with a woman forcibly and without r consent is an ancient social problem wh ch has concerned men and women ke in societies at all levels of social and political complexity It is often con lered a crime – indeed most definitions state that it is a crime [Cou_hlin 1975 295 Webster 1973 p 1494] and as a crime it is frequently subject to punish ›nt Inherent in the belief system of some cultures including those in Western alization is the notion that the application of punishment will prevent rape is belief constitutes a deterrence theory of rape This paper reports a cross ltural study of rape in which this theory is t sted using a sample of societies awn from the Human Relations Area Files A second theory fraternal interest oup theory is also tested Unlike deterrence theory whi h sets forth a condition punishment – for the suppression of rape fraternal interest group theory sets rth the conditions which give rise to high frequencies of rape The theory argues at th presence of fraternal interest groups which are power groups of related ales that resort to aggression to d fend members interests predicts the occur nce of rape in a society

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## METHODOLOGY

### Sample

The cross cultural survey or hologeistic method is used to test the theories. Such a cross-cultural study typically utilizes a large sample of nonliterate societies often they are drawn from the Human Relations Area Files (HRAF) a massive compilation of indexed but uncoded ethnographic material on nearly 300 societies [Lagacé 1974] While several steps are normally followed in conducting a cross-cultural study [Otterbein 1969] the essence of the method is the simultaneous examination usually by statistical methods of a set of variables common to the entire sample thus the hologeistic method is a way of processing a large number of case studies at once The sample used in this study was drawn from HRAF by Minturn Grosse and Haider to demonstrate the Cultural Patterning of Sexual Beliefs and Behavior [1969] Included in the study were two variables dealing with rape Codes for each variable were included Data on other variables were taken from other sources one source – the Ethnographic Atlas [Murdock 1962 1967] – contained coded data for most of the societies in the sample the other source [Otterbein and Otterbein 1965] for only a small number of these societies

### Measures

To test the above theories data were obtained on the frequency of rape its punishment the presence of fraternal interest groups and the frequency of feuding Seven point scales were used by Minturn Grosse and Haider [1969 p 315] to obtain data on the frequency and punishment of rape

Frequency of Rape for Men

1 Concept of rape is absent or rape reportedly never occurs
2 Rape does not occur but the concept is present
3 Rape is very rare
4 Some aggressive seduction is reported
5 Rape is not uncommon
6 Rape or aggressive seduction is the preferred form of sexual activity
7 All sexual relations are viewed as aggressive

Punishment of Men for Rape

1 Death
2 Exile
3 Heavy official fines or punishment by government
4 Fine paid to woman s family or small fine paid to government
5 Man may or may not be punished depending upon the sex partner
6 No official punishment or social stigma man is ridiculed
7 No punishment fine or social stigma

Cod d data for the other variables derive from other sources The procedures used in indexing fraternal interest groups are identical to those followed in previ ous studi s [Otterbein and Otterbein 1965 p 1471 Otterbein 1968a p 278]

Two factors which should lead to the formation of fraternal interest groups are a marital residence pattern in which the new family lives with or near the groom s relatives and the presence of polygyny both indices were de rived from the codings given by Murdock in the Ethnographic Atlas [1962 pp 117–118] A society was considered to be *patrilocal* if the residence pat tern was listed as patrilocal (P)* avunculocal (A) virilocal (V) ambilocal wh re the majority of couples live with the groom s relative (D) or where a common household is not established but the men of the community either remain in their natal households or live in special men s houses (O) Societies were coded as *other* if the residence pattern was matrilocal (M) uxorilocal (U) neolocal (N) or ambilocal where the residence was not consistently with the kin of *either spouse* but was determined by personal cir umstances (B C) The symbols in column 14 of the Atlas [*1962 p 116*] were used to code for the presence of polygyny (P Q R and S or E F and with either p q r or s followin ) and its absence (E F G M N and O)

d data on residence and polygyny came from the Ethnographic *Atlas* [Mur 1962 1967]

odes for the frequency of feuding were taken from Otterbein and Otterbein 5 p 1470]

uding was defined as blood revenge following a *homicide* Ethno aphic materials available in the Human Relations Area *Files* (*HRAF*) re used for this measure and were coded on a three point *scale fre* ent infrequent or absent A society was considered *to have frequent* iding if after a homicide the kin of the *deceased* was *expected to take* enge through killing the offender or any *member of his* kin group If the of the deceased sometimes would accept *compensation* in lieu of such enge the society was coded as having *infrequent feuding* Feuding was isidered to be absent in those *societies which had formal* judicial proce es for punishing the offender which always settled such matters through npensation or which were *reported* to rarely have homicide

se this sample differs from the sample having data on rape the number of es found both in this sample and *the rape* sample is small +

ll letters in *parentheses* are *code* symbols used in column 16 of the Ethnographic Atlas

or problem confronting any *future* cross-cultural study of rape is data paucity In the of 135 societies data were *found* on frequency for 43 societies and on punishment ocieties It has been the awareness of data pa ity brought to my attention first ald F *Griffiths* who ha ondu *ted a* cross-cultural study of crime whi h has deterred n drawing my own sampl *and* h *ring* coders. During the spring of 1977 two students ting cross-cultural studies un *der my* direction in HRAF encountered great difficulties g due to the la k of sample data on rape for most societies

## RESULTS

### Fraternal Interest Group Theory

Nearly twenty years ago van Velzen and van Wetering set forth fraternal interest group theory [1960] to explain why some societies were internally peaceful while other were non peaceful They argued that a fraternal interest group which is a power group of related males resorts to aggression when the interests of one of its members are threatened [1960 p 179] The authors set forth their theory in the following manner [1960 p 180]

> (1) In societies with power groups every act of violence elicits a chain reaction and there is danger of any individual deed of aggression leading to group conflict Much intra societal aggression can be attributed to the existence of power groups Where they are not present there will be no struggle for power at group level
>
> (2) Violence can be more effectively suppressed if the individual concerned is not part of a power group which is ready to support him through thick and thin Bystanders who separate and restrain combatants can curb a great deal of potential aggression The individual lacks the psychological assurance of a reliable stronghold behind him
>
> (3) In societies where there are no power groups differences in power will merely consist of differences in muscular strength and personality And violent treatment of the socially weak is also much less frequent

Cross cultural support was found for the hypotheses derived from the theory The theory was elaborated and extended by Otterbein and Otterbein to encompass two forms of intergroup violence – feuding (which occurs between kinship groups within a political community) and internal war (which occurs between political communities within the same culture) In two cross-cultural studies it was shown that the presence of fraternal interest groups predicts feuding and internal war [Otterbein and Otterbein 1965 Otterbein 1968a 1968b]

The presence of fraternal interest groups was indexed either by patrilocality or polygyny Patrilocal residence it was argued *results in a settlement pattern in which related males live close together* when such a condition exists the men will look after each other s interests and welfare Polygyny produces a similar situation adult unmarried half brothers may be living near each other because polygyny frequently delays marital age for young males The absence of fraternal interest groups was indexed by matrilocality or some other form of residence which does not group males locally the absence of polygyny would have the same effect If residence practices and marriage rules result in the scattering of related males over a large area it is difficult for them to support each other s interests

Fraternal interest group theory as noted above has been used to explain high incidences of interpersonal violence within local groups feuding and internal war The theory can be expanded to encompass rape which is a form of inter personal violence Since it has been shown that societies with fraternal interest groups are internally non peaceful and that rape is a violent act it can be pre dicted that societies with fraternal interest groups will have high frequencies of rape Indeed rape may be directly associated with other forms of violence So cieties with fraternal interest groups are societies which engage in feuding and internal war It is often noted in the ethnographic literature that rape is a cause of feuding and warfare On the other hand one aggressive act of fraternal interest groups may be to attack and rape women It appears from ethnographic accounts that the motive is often to defile the enemy by violating his women valued pos sessions of the enemy Thus feuding and internal war can be precipitated by rape or rape may be an aggressive act resulting from feuding or warfare

Since rape is a violent sexual act of an individual male fraternal interest group theory as an explanation for rape can be questioned because the theory stresses both group action and group responsibility Ethnographic accounts however indicate that rape is often perpetrated by several males for example the Higi of northeastern Nigeria frequently become embroiled in internal wars due to raids which resulted in abduction or rape [Otterbein 1968c p 208] Brownmiller s [1975] comprehensive review provides many examples of gang rape Further more even if a man acts alone he has the support of male kin if he is a member of a fraternal interest group Indeed it is his awareness of such available support which is a key element in fraternal interest group theory [van Velzen and van Wetering 1960 p 180]

From this theory the following hypothesis can be derived *Societies with fraternal interest groups are more likely to have a high frequency of rape than societies without fraternal interest groups* The hypothesis was tested by indexing with the presence or absence of patrilocal residence The relationship between residence and frequency of rape is shown in Table I The frequency of rape variable was dichotomized as close to the median as possible 1–3 = low frequency 4–7 = high frequency A moderately strong correlation ($\phi = 0.36$) which is statistically significant ($0.01 < P < 0.02$) is obtained The hypothesis can also be tested by indexing with the presence or absence of polygyny The relationship between polygyny and frequency is shown in Table II A weak non significant correlation ($\phi = 0.16$) is obtained * It can be cautiously concluded on the basis of these two tests that there is moderate support for the hypothesis

*Bacon Child and Barry [1963 p 294] found that polygynous households were associated with a high frequency of personal crime (by definition rape was considered a personal crime) a result consistent with the hypothesis

**TABLE I Relationship Between Residence and Frequency of Rape**

| | Frequency of rape | | |
|---|---|---|---|
| Residence | Low | High | Total |
| Patrilocal | 9 | 16 | 25 |
| Other | 13 | 5 | 18 |
| Total | 22 | 21 | 43 |

$\phi = 0.36$ $\chi^2 = 5.50$ $0.01 < P < 0.02$

**TABLE II Relationship Between Polygyny and Frequency of Rape**

| | Frequency of rape | | |
|---|---|---|---|
| Polygyny | Low | High | Total |
| Polygyny present | 9 | 12 | 21 |
| Polygyny absent | 13 | 9 | 2[illegible] |
| Total | 22 | 21 | 43 |

$\phi = 0.16$ $\chi^2 = 1.13$ n.s. = no significance

A second hypothesis can be derived from the theory. *Societies with a h[illegible] frequency of rape are more likely to have frequent feuding than societies w[illegible] low frequency of rape.* The relationship between feuding and frequ[illegible] is sh[illegible] in Table III. A strong correlation ($r_c = 0.75$) which is statistically signific[illegible] ($P < 0.005$) is obtained. However, the small number of cases (N = 1[illegible]) [illegible] cautious acceptance of the results. (No test was made for the relations[illegible] internal war and frequency because only five cases were availabl[illegible].) S[illegible] has been found for both hypotheses derived from fraternal interest gr[illegible] it can be concluded that there is some support for the theory.

### Deterrence Theory

The notion that certain behavior on the part of individuals or gr[illegible] can be [illegible] presented by prior appropriate actions is known as d[illegible] theory. S[illegible] of military affairs have argued that an efficient military organ[illegible]

**TABLE III** Relationship Between Frequency of Rape and Feuding

| Frequency of rape | Frequency of feuding | | | |
|---|---|---|---|---|
| | Frequent | Infrequent | Absent | Total |
| Low | 0 | 4 | 3 | 7 |
| High | 3 | 2 | 0 | 5 |
| Total | 3 | 6 | 3 | 12 |

$\tau_c$ = 0 75 $P < 0\ 005$ using Fisher s Exact Test *

* For the calculation of Fisher s Exact Test the trichotomized variables in this and each of the following tables were dichotomized as close to the median as possible

ould be aggressors from attacking [Otterbein 1970 p 88–92] while students f crime have argued that punishment or the threat of punishment will deter po ential criminals from committing crimes [Kadish and Paulsen 1975 p 21–33 acker 1968 p 39–48] Deterrence theory as applied to the study of criminal ehavior has been delineated as follows [Packer 1968 p 39]

> The classic theory of prevention is what is usually described as deterrence the inhibiting effect that punishment either actual or threatened will have on the actions of those who are otherwise disposed to commit crimes Deterrence in turn involves a complex of notions It is sometimes described as having two aspects after the fact inhibition of the person being punished special deterrence and inhibition in advance by threat or example general deterrence

Forcible rape is considered one of the four most serious crimes in the United ates Along with willful homicide aggravated assault and armed robbery it is ewed as being appropriately subject to the criminal sanction [Packer 1968 296–301] A major purpose for applying a criminal sanction is to prevent or ter an act *Deterrence* theory is found in the literature on rape prevention ownmiller s study concludes with a series of recommended changes in sexual ault legislation which are intended to deter rape [*1975* p *379–389*] She tes [1975 p 379]

> I am one of those people who view a prison sentence as a just and lawful societal solution to the problem of criminal activity the best solution we have at this time as civilized retribution and as a deterrent against the commission of future crimes

From this deterrence theory of rape can be derived the following hypothesis *The greater the punishment for rape the less likely that rape will occur* In testing the hypothesis the seven point scale of punishment of men for rape was trichotomized 1 2 3 = major punishment 4 5 = minor punishment and 6 7 = no punishment Frequency of rape was measured as above with a dichotomous variable The relationship between punishment and frequency is shown in Table IV A strong negative correlation ($\tau_c = -0.68$) which is statistically significant ($P < 0.025$) is obtained This inverse relationship between the severity of punishment and the frequency of rape provides support for the hypothesis and the theory from which it is derived *

### Further Analysis

Examination of the hypothesis test results indicates more support for deterrence theory than for fraternal interest group theory Although the correlations are not directly comparable – the $\phi$ coefficient is related to the Pearson $r$ while $\tau_c$ is not – the magnitude of the difference between a $\phi$ of 0 36 (see Table I) and a $\tau_c$ of 0 68 ignoring the negative sign (see Table IV) suggests that the latter test result is the stronger Both the significance levels and visual inspection of the tables support this conclusion Rather than concluding that there is more support for deterrence theory than for fraternal interest group theory it is possible – using a three variable analysis – to examine the interaction between fraternal interest groups and punishment and their joint effect upon the frequency of rape in societies The procedure followed here is to reexamine the results of Table IV by

**TABLE IV Relationship Between Punishment and Frequency of Rape**

| | Frequency of rape | | |
|---|---|---|---|
| Punishment | Low | High | Total |
| Major | 8 | 3 | 11 |
| Minor | 3 | 4 | 7 |
| None | 0 | 10 | 10 |
| Total | 11 | 17 | 8 |

$\tau_c = -0.68$ $P < 0.025$ using Fisher s Exact Test

*Controlling for level of political complexity using codes from the Ethnographic Atlas (Murdock 1967 p 160) has no measurable influence upon the relationship – that is, the inverse relationship holds for both uncentralized and centralized political communities

controlling for the presence and absence of fraternal interest groups using the two measures of fraternal interest groups – patrilocality and polygyny (see Tables V and VI) Since the results of the three variable analysis using either index are nearly identical Tables V and VI will be discussed simultaneously

Three important findings emerge from the three variable analysis 1) Stronger results are obtained for deterrence theory if fraternal interest groups are absent than if they are present (compare the right side of Tables V and VI with the left side of the same tables) Both visual inspection and the larger $\tau_c$ s support this finding 2) The deviant cases in Table IV (ie cases in which major punishment is present and the frequency of rape is high) are explained by the presence of fraternal interest groups All three of these cases have both polygyny and patrilocal residence and are to be found on the left side of Tables V and VI Looked at in another way when fraternal interest groups are present major punishment and a high frequency of rape in a society are as likely to occur together as not (about a

TABLE V Relationships Among Punishment Frequency of Rape and Residence

| | Patrilocal | | | Other | | |
|---|---|---|---|---|---|---|
| | Frequency of rape | | | Frequency of rape | | |
| Punishment | Low | High | Total | Low | High | Total |
| Major | 3 | 3 | 6 | 5 | 0 | 5 |
| Minor | 1 | 3 | 4 | 2 | 1 | 3 |
| None | 0 | 6 | 6 | 0 | 4 | 4 |
| Total | 4 | 12 | 16 | 7 | 5 | 12 |

$\tau_c = -0.42$ not significant
$\tau_c = -0.81$ $P < 0.05$ using Fisher s Exact Test

TABLE VI Relationships Among Punishment Frequency of Rape and Polygyny

| | Polygyny present | | | Polygyny absent | | |
|---|---|---|---|---|---|---|
| | Frequency of rape | | | Frequency of rape | | |
| Punishment | Low | High | Total | Low | High | Total |
| Major | 4 | 3 | 7 | 4 | 0 | 4 |
| Minor | 2 | 3 | 5 | 1 | 1 | 2 |
| None | 0 | 4 | 4 | 0 | 6 | 6 |
| Total | 6 | 10 | 16 | 5 | 7 | 12 |

$\tau_c = -0.42$ not significant
$\tau_c = -0.94$ $P < 0.01$ using Fisher s Exact Test

50–50 chance) when they are absent major punishment and a high frequency of rape are not found to occur together 3) Societies for which there is no punishment for rape have a high frequency of rape whether fraternal interest groups are present or absent (examine the lowest row of both sides of Tables V and VI)

These findings can be summarized in a paradigm which shows how the combinations of traits predict the frequency of rape found in a society

major punishment + no fraternal interests groups → frequency of rape is low
*major punishment + fraternal interest groups → frequency of rape may be high or low*
no punishment + no fraternal interest groups → frequency of rape is high
no punishment + fraternal interest groups → frequency of rape is high

These findings indicate that while there is more support for deterrence theory than for fraternal interest group theory neither theory alone gives as complete a picture as does a composite theory based upon the key independent variables in each of the separate theories

## CONCLUSION

The results of this cross-cultural study of rape have provided support for both fraternal interest group theory and deterrence theory with stronger supporting evidence for the latter * Further analysis of the data however showed the usefulness – indeed I feel the necessity – of employing the key independent variables in a three variable analysis Two conditions appear to be characteristic of societies in which there is no rape – major punishment and the absence of fraternal interest groups Major punishment alone however does appear to [illegible] reduce the frequency of rape in a society Moreover it has been found that if there is no punishment the frequency of rape is high Societies with fraternal interest groups have a high rape frequency if there is no punishment however if there is punishment either major or minor the frequency of rape may be either high or low It appears thus that the presence of fraternal interest groups may override to some extent the influence of punishment in reducing the frequency of rape in a society Nevertheless the results suggest that strong sanctions decrease the frequency of rape implying that penalties deter rape It should also be pointed out that since the frequency of rape is high if punishment is absent and if fraternal interest groups are absent the presence of fraternal interest groups does not predict rape

* Before the testing of the hypotheses the author had predicted that fraternal interest group theory would receive support as it had in several other studies and that deterrence theory would not receive support for the same reason The results thus came as a surprise

From the analysis of the data a compo ite theory has emerged which com ines the two theories which this study set out to test The above paradigm sum anz s the new theory No encompassing social science expression such as deter nce or fraternal interest group theory is yet available to describe it However ...ther of the two theories initially tested has the explanatory power of the composite theory

## ACKNOWLEDGMENTS

I am indebted to Charlotte Swanson Otterbein for helpful comments and criticism on this article My thinking about rape has benefited from conversa tions with Gay E Kang Doris M Lemieux and Julius C Richardson

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social order the focus is often exclusively on the use of more and more sophisticated technology At first this seems to be even handed liberal editorialism but on second reading it turns out to be either meaningless or an evasive def s of the status quo by the use of sermonial platitudes

The remaining chapters are manuals for policy makers and police chiefs and they may be useful to both One bit of advice (coming originally form L C Green who is not one of the authors but seems to be the source of many of their ideas) deserves to be quoted Any attempt to cope with terrorism must be directed to the act rather than the actor so that sympathy for those who commit the alleged terrorist act must not be allowed to invalidate condemnation of the act This certainly makes sense and it is a part of a general model of prevention suggested by the authors A more serious scholarly discussion of the issue would have led them to ask when and where is that model followed and how Most often as we well know attempts to divert attention from the actor to the act have failed Only the completely ahistorical approach of the auth rs allows them to entertain seriously such suggestions The recommendation has been given to many governments on unnumbered occasions of insurrection a d restlessness What government in recent memory has not condemned the criminal acts of a small band of terrorists ? The people who have issued such statements have no PhDs in criminology sociology or psychology but they accept the great principle of separating the act from its context

Chapter 5 is devoted to Problems of Institutionalizing Political Terrorists (as opposed to nonpolitical ones?) and is a brief manual for prison wardens on how to keep political prisoners under control in the most elegant way phras in social science jargon It reminded this reviewer of the memoirs of Russ revolutionaries imprisoned in the Peter and Paul fortress in St Petersbu g in Czarist days Those prisoners were well aware of the ideas contained in th s chapter as were their wardens

The chapters devoted to different countries contain some interesting inf rmation which may be of use as raw material but offers little in the way of [illegible] analysis The writers often sound like official representatives of their gov [illegible] and for one (Erich Corves) that impression is confirmed by a governm nt a [illegible] ment One tends to suspect that scholars critical of their governments were [illegible] invited to the conference Of special interest are Chapter 12 ( Politi al Prisoners and Terrorists in American Correctional Institutions ) and Chapter 14 ("[illegible] Facts on Internment in Northern Ireland ) Chapter 12 has only five a [illegible] pages on the stated ground of lack of matter Chapter 14 is the l [illegible] most unusual in the book It was not presented at the original confe ence [illegible] reprinted from a Northern Ireland periodical The reasons for its [illegible] obscure for its frame of reference is totally different from that of the o [illegible] chapters

Now I turn to what the authors have avoided namely looking at a social phenomenon in its social and historical context

Terrorism in the past 15 years has outstepped its recognized borders to bring the horrors of insecurity and violence deep inside the First World Stemming either from struggles between the First World ( Western democracies ) and the Third World or from internal upheavals and instability within those Western democracies every act of terrorism was a reminder of the gap between technological control which has been achieved and social domination which is still incomplete The reaction of governments as the authors of this book point out was mostly technological The authors have sought to prove that social control can be as advanced as technological control The book and the conference behind it then become a case study in the philosophy and practice of modern social science When a problem is identified as social rather than moral or political there the social scientist is found seeking research grants and offering solutions In this case when terrorism and skyjacking were seen as a problem for Western democracies somebody said Let s have a scholarly conference The authors who are all scholars in the social science known as criminology secured financial support from the US and Canadian governments for a conference which brought together government officials legal scholars and criminologists The legal scholars and the government officials as would be expected represented official viewpoints From social science scholars we expect illumination and insight related to social phenomena Instead we get a model of how not to do scholarly analysis The guiding rule seems to be Ignore the context of what you are looking at No interest is shown in the background of terrorist acts since the goal is prevention and control not understanding The goal is a better technology – a social technology presented by the social sciences to match that of the natural sciences

W H Auden is reported to have said Thou shalt not commit social science After reading this volume it is easy to see why

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## A History of Aggression in Freud by Paul Stepansky New York International Universities Press 1977 pp ix + 201

This book traces the development of Freud s ideas about aggression and the part it plays in human behavior It is a dense book full of psychoanalytic terminology of no use to the reader casually interested in psychoanalysis but directed to psychoanalysts or historians of psychoanalysis

In 1908 Alfred Adler first wrote about what he called the aggressive instin t (German Trieb) Not until eleven years later in the year after the ending of the First World War did Freud himself in *Beyond the Pleasure Principle* begin to write in terms of the aggressive instinct According to the dust-cover the aim of Stepansky s book is to dispel the mistaken belief that it was only the impetus of World War I that forcibly turned his attention to the importance of aggression It is worth mentioning that at the beginning of 1920 Freud s daughter Sophie and Anton von Freund Freud s friend and benefactor died within a few days of each other leaving Freud with what he described as a bitter irreparable narciss i hurt and morbid fears about his own ultimate death

Stepansky convincingly shows that Freud rated highly the importance of a— sion in personality development long before these events Certainly by the time he was beginning to write about the Oedipus complex in the *Interpretation of Dreams* in 1900 the role of aggression became central to Freud s thinking Stepansky makes the important point that the Oedipus myth was invoked originally to explain not infantile sexuality but fantasied aggression such as the death wish occurring in dream life

The First World War far from focussing Freud s attention on aggression so appalled and frightened him that he was driven to rationalise in terms of bio— need this explosion of irrational and destructive behavior In an open letter to Einstein Freud wrote War is in the crassest opposition to the psychical att— imposed on us by the presence of civilisation and for that reason we are bo— d to rebel against it – we simply cannot any longer put up with it

At first Stepansky suggests Freud tried to deal with the terrible feel ng that the First World War produced in him by talking about a healthy hating ego T— ability of the ego to hate was seen as necessary *to help it in its strug le to p— e* and maintain itself (*Instincts and Their Vicissitudes* 1915)

The First World War could then be seen as a perverted but biol gicall— u— standable struggle for survival By the time of publishing *Beyond the P— sure Principle* in 1920 Freud had gone even further in taking the sting out of Man s aggressiveness by suggesting that it was an aspect of his newly discovered d— h instinct Freud here began to talk in what Stepansky describes as obscure — terms By now life had become merely a circuitous path returning to — existence called by Freud the Nirvana Principle (adopting a term co—ed by

:a Low) He no longer thought of war as tapping an immanent aggressiveness i but as anticipating an inevitable entropy Thus war became the result of 'e external influences acting through biological drives outside Man s control ldenly in the middle of the book Stepansky begins to discuss Freud s ns with Adler This makes interesting reading but would have made more n a separate essay (Stepansky is writing a book about Adler ) Stepansky :s that Freud over reacted to Adler and indeed misinterpreted him In a ice to Adler s work in the Little Hans history Freud wrote I cannot myself to assume the existence of a special aggressive instinct alongside of miliar instincts of self preservation and sex and on an equal footing with In fact Adler was not particularly interested in the Freudian concept of :t aggressive or otherwise Adler s was an ego psychology children suffer ;s of inferiority because they *are* inferior to adults (in strength and knowledge) eir personality is moulded by masculine protest against their state of in ty Stepansky raises the question why did Freud over react to Adler s :s? The answer he gives is that for for Freud Adler was a revenant of his :r brother Julius who lived only a few months This death Stepansky sug eft Freud with feelings of great power but with terrifying feelings about ssible effects of his own aggressiveness When Freud began to see that Adler s vere diverging from his own he rationalized his resulting fury by dismissing s ideas on the theoretical grounds that Adler s work over-emphasized the ance of aggression at the expense of sexuality Hence even the founder of analysis was not immune to the human tendency to project unwanted its and feelings on the others

; a general criticism of psychoanalysis that its methods of investigation are erably influenced by the psychodynamics of its practitioners Stepansky s aises a question not answered by him at all can psychoanalysis be said to ientific discipline? This is a scholarly and very thoroughly researched book to be of considerable value to students of psychoanalysis but the account gives of the development of Freud s ideas would I fear confirm all the fears of those who are already sceptical about psychoanalytical concepts chnique

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AGGRESSIVE BEHAVIOR
Volume 5 pages 443–453


# ι Guide to the Literature on ιggressive Behavior

Articles relating to the general problem area of aggression are scattered ·oughout the whole range of specialized journals in fields from A for ıtomy to Z for Zoology It is virtually impossible for a single individual find all the articles which may bear on his particular interest Information ·rload is of course a problem However an even greater problem is match . the interesting article with the interested reader Aggressive Behavior will empt to alleviate this problem by publishing a list of references in each ıe The reference list will be compiled from several sources Each article ed in Psychological Abstracts and indexed under the following terms will included

1 Aggressive Behavior
2 Anger
3 Animal Aggressive Behavior
4 Attack Behavior
5 Hostility
6 Threat Postures
7 Violence
8 Frustration
9 Conflict

Each reference will be coded according to the index terms listed above and l be listed in alphabetical order by senior author There are a large numl ι r of rnals that publish articles related to aggression that are not covered by Psy ·logical Abstracts In order to find such references the cooperation of all ders of this journal is needed If each of the several hundred investigators ıcerned with the problem of aggression makes a habit of contributing to the rature search section of *Aggressive Behavior* the search task of each of us l be made easier If in your coverage of the literature you find an article about ression in a journal *that is not* regularly abstracted by Psychological Abstracts the full reference on a 3 X 5 card and send it to the editor for inclusion in ; section

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1 Aggressive Behavior 2 Anger 3 Animal Aggressive Behavior 4 Attack Behavior [illegible] 7 Violence 8 Frustration 9 Conflict

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